ELECTRICAL REVIEW

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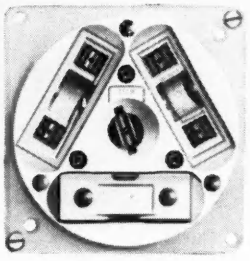

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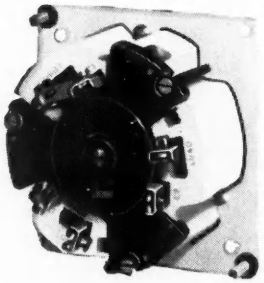
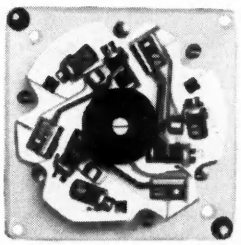


Wiring is especially easy. Heavy clamp terminals are provided and are clearly identified. An indicator shows whether the switch is on or off.



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17 MAY
1957

ELECTRICAL REVIEW

Managing Editor: HUGH S. POCOCK, M.I.E.E. *General Editor:* J. H. COSENS *Technical Editor:* P. W. TUCKER, M.I.E.E.

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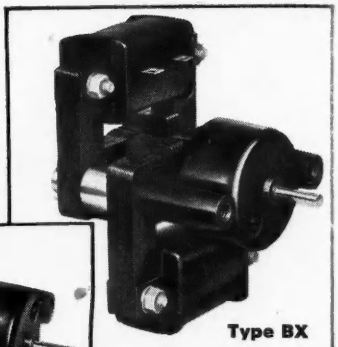

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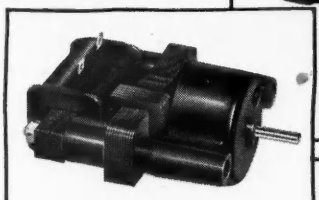

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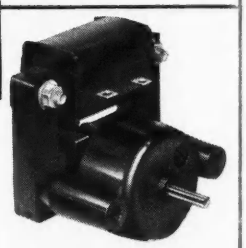

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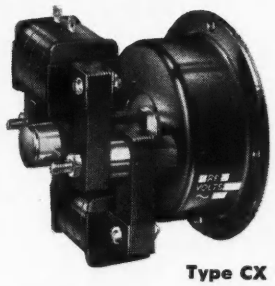

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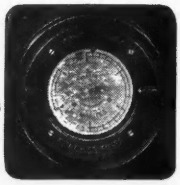

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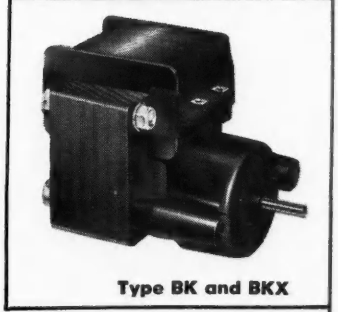

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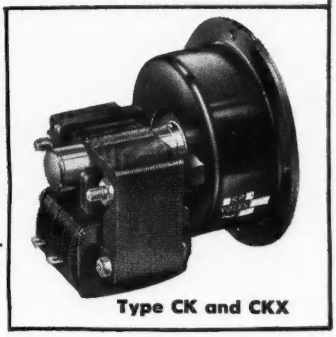

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ELECTRICAL REVIEW

17 May 1957 Vol. 160 No. 20 Established 1872

Technical Training in Industry

NO doubt in the preparation of White Papers and reports on technical education and training full account is taken of the views of those who have to administer and conduct this work, but it is salutary to receive at first hand the opinions and ideas of these people. Such an opportunity occurred at the Education Conference arranged by the British Electrical and Allied Manufacturers' Association in London last week.

One word which cropped up frequently during the discussions (reported on page 925) was " investment "—a reminder that training and education schemes cost money but that it is money well spent. It is generally true that, because of the expense involved, only the larger concerns in the industry have felt able to institute really adequate training systems. Very often such schemes necessitate the provision of hostels for the students with all kinds of amenities, or the provision of sufficient funds to enable them to live in lodgings, quite apart from the strictly educational costs.

A number of leading electrical concerns have, in effect, trained men for the whole of the industry, for once the apprentices have finished their courses they cannot be held if they want to go elsewhere. But even if they do not stay, the fact that they are ex-apprentices of a well-known company redounds to the credit and reputation of that company.

It seems that the main purpose of the B.E.A.M.A. Conference was to stimulate the interest of the not-so-large concerns and to suggest to them how they can introduce suitably modified training courses for promising boys (and girls) in their districts, possibly by co-operative arrangements, as in the case of the Scottish Electrical Training Scheme.

The discussions appeared to reveal some inadequacy in the training of technicians—described by Mr. A. J. Nicholas as the " non-commissioned officers of industry." There is a need for courses catering directly for this grade for in many cases, it was said, technicians were recruited from those who excelled in the craftsmen's courses or those who failed to " make the grade " in technology. There is also a case for the separate treatment of draughtsmen, who are in the technician class, and on whom much depends in the matter of smooth production.

There are great possibilities for women in technical positions but their employment raises several special problems, although it was stated that in actual training young men and women worked quite well together. Indeed it appears that the feminine influence is often beneficial in keeping the male element up to scratch. These are but few of the practical points raised at the Conference which, as we implied at the beginning, was a valuable and stimulating occasion.

NUCLEAR POWER PROGRESS

The first stage of the British industrial nuclear power programme is based on gas-cooled, graphite-moderated reactors of the Calder Hall type. These will probably be followed by liquid-cooled thermal reactors and then by reactors of the fast breeder type such as is being constructed at Dounreay. Calder Hall type reactors are large and use natural uranium as fuel, whereas breeder reactors are small and use highly enriched uranium or plutonium, and at the same time have a much higher heat rating. The whole future of our nuclear power programme depends on the successful operation of the Dounreay breeder reactor since it can operate on the plutonium produced in Calder Hall type reactors, and " breed " further fissile material which can be used in the latter.

The breeder reactor, together with a heavy water moderated materials testing reactor, are being built at Dounreay to provide advance information on components and materials for both the second and third stages in our power programme and although a certain amount of electricity will be generated using heat from the fast breeder it should be pointed out that this is purely experimental. Dounreay is not a power station in the same sense as Calder Hall. Finally, it should be emphasised that the fast breeder at Dounreay is completely safe and can in no way explode like an atomic bomb. Even under the worst conditions of failure only local damage would be caused inside the reactor itself and there would be no danger to buildings or persons in the immediate vicinity of the plant.

REACTOR LOAD CONTROL

Among the possibilities of " Zephyr," Britain's first fast reactor, installed at the Atomic Energy Research Establishment at Harwell, is ease of control under varying load conditions. Experiments have shown that the chain reaction in the modified equipment can now be controlled, as in a thermal reactor, by putting an absorber of slow neutrons, such as cadmium, into the graphite. Graphite has been substituted for the uranium bars which originally formed the outer reflector, while the thin inner reflector of uranium still surrounds the plutonium core.

In its new form the reactor diverged with a critical mass of plutonium very close to that in the uranium reflected system. Because the neutrons reflected back into the inner reflector have been slowed down " Zephyr " now shows some of the characteristics of a thermal reactor.

550 MW TURBO-GENERATORS

When it was announced last December that the Central Electricity Authority was planning to install a 550 MW turbo-generator as a part of its 1962 programme manufacturers professed to be as surprised as we were at the sudden jump in size. The Authority has now decided on a site for a new 1,100 MW power station at Thorpe Marsh, near Doncaster, in which this size of set will be installed and so we may hope to hear fairly soon who is to make the sets—presumably two. Transport limitations restrict the maximum size of generating sets to 275 MW and so the new sets will actually be two-shaft cross-compound units with two generators. Considerable economy in operation is expected to be achieved although the steam conditions (2,300 lb/sq in and 1,050 deg F) will be comparable with those to be employed in the 200 MW sets already being constructed. In its December announcement the C.E.A. mentioned that work was continuing on even more advanced machines for future programmes and on materials and techniques for possible higher steam pressures and temperatures.

HUNTERSTON DELAY

It was in December last that the South of Scotland Electricity Board announced the placing of a contract with the G.E.C. - Simon-Carves Group for a 360 MW nuclear power station which it was intended to erect at Hunterston on the Ayrshire coast. There were thirty-three objectors to the use of the site chosen and so the Secretary of State for Scotland ordered a public inquiry and appointed Sir Randall Philip, Q.C., to conduct it. The inquiry opened on 29th January and went on until 8th February. Soon afterwards it was announced that Sir Randall Philip was ill and unable to make his report and he subsequently died.

Now the Secretary of State has decided that a second inquiry must be held and Sheriff H. R. Leslie, Q.C., is to conduct it. Naturally a full record of the evidence at the original inquiry is available and it is to be hoped that it will be examined and reported on to avoid going through the whole procedure a second time. In the meantime this important work is held up to the great disadvantage of Scotland and the companies who are to erect the station.

ENGINEERING WAGES

It was generally believed that the decision of the Amalgamated Engineering Union to accept the engineering employers' offer of an 11s a week wage increase, subject to certain conditions, would influence the other organisations in the Confederation of Shipbuilding and Engineering Unions to give general approval to this step. But when the matter went to the vote last week the executive council was given a free hand to resume negotiations with the employers in order to get the best possible terms. The meeting was taking place yesterday (Thursday).

The proposal of the A.E.U. was to endeavour to secure a modification of the terms upon which the 11s was offered. These, it will be remembered, included a wages " standstill " agreement valid for at least a year. As, however, the Union is pressing for a 40-hour week, with all its implications, the value of such an undertaking is very doubtful.

In the next of our illustrated surveys of domestic electrical appliances (24th May) we shall be dealing with refrigerators. Particulars, given in tabular form, will include details of type, size, cubic capacity, shelf area, special features, loading, finish, price, purchase tax, etc. The subject of the following survey (14th June) will be electric toasters

Electrical Review 17 *May* 1957

DOUNREAY

EXPERIMENTAL FAST BREEDER AND MATERIALS TESTING REACTORS

THE first stage of the British industrial nuclear power programme has been based on gas-cooled, graphite-moderated reactors of the Calder Hall type. It is expected that these will be followed by liquid-cooled thermal reactors, and then by reactors with a "positive gain factor" to allow a much higher utilisation of fuel. Research and development work is well in hand on the advanced reactor types indicated above and at the Dounreay establishment of the United Kingdom Atomic Energy Authority the engineering, chemical, irradiation and safety problems of the operation of these reactors are being investigated on an industrial scale. Last week we had the pleasure of visiting Dounreay to inspect the two reactors which are at present under construction. These are a fast breeder and a materials testing reactor.

From the experimental fast breeder reactor, which belongs to Stage 3 of the programme, will come the operating experience necessary for commissioning an advanced machine and experimental data on the behaviour of fuel elements, cooling systems, and control techniques. To commission and maintain the reactor in operation, a fuel element plant is required, together with chemical processing facilities to refabricate the fuel into new elements. Recovery of residues and the treatment and storage of active effluent are essential processes in this fuel cycle, to which must be added analytical control in the various plants. New or improved chemical processing methods will form part of the research and development programme. When the appropriate point is reached, the thermal output of the reactor will be linked to a 15 MW electrical generating plant, but the main purpose of the reactor is experimental.

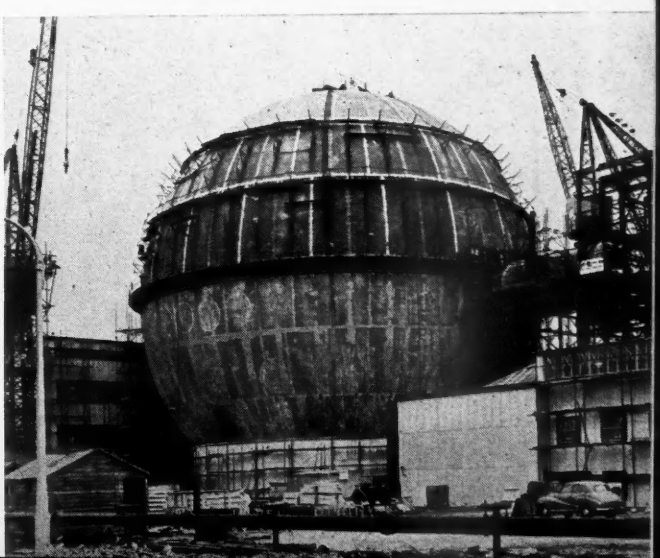
The improvement in heat rating of Stage 1 reactors, and the development work necessary to implement Stage 2, will depend to some extent on irradiation testing of new materials, components and coolant systems. The Industrial Group of the Authority is building its first materials testing reactor at Dounreay for applied research and development connected with all types of reactors which are direct commitments on the Group. Similar testing reactors at Harwell, DIDO and PLUTO, will be engaged on longer-term projects. Work for the civil nuclear power stations, both present and future, will be included in the programme. Initial exploratory tests on fast reactor materials will be carried out in the Dounreay materials testing reactor before final application as complete components in the fast reactor itself. As with the latter, the Chemical Group at Dounreay will fabricate fuel elements and process these after irradiation.

Research and development in special reactor experiments is already proceeding in the Experimental Criticality Group on the site. The fabrication of fuel elements utilising new and improved fuel materials, including plutonium, will be developed not only for the fast reactor, but also for existing and future reactors under consideration by the Industrial Group.

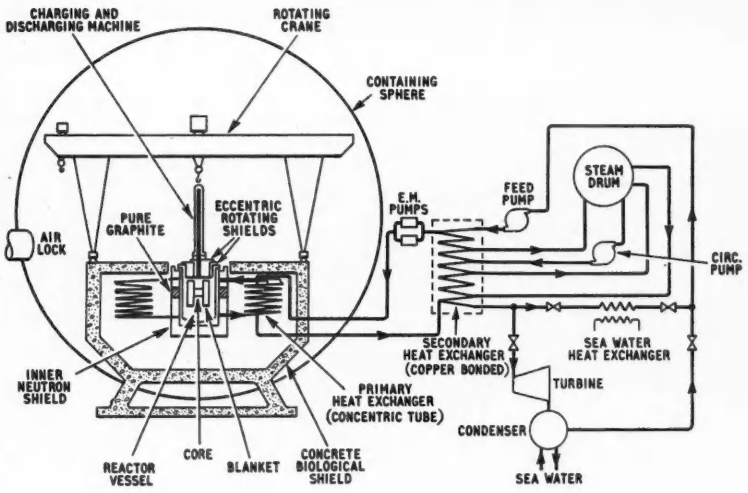
The Dounreay Works is thus contributing to Stage 3 developments of the power programme by operation and experimental use of the fast reactor, and to Stages 1, 2 and 3 with irradiation experiments in the testing reactor. To this must be added applied research and development on fuel elements and criticality problems, which are linked to a wide field of the Atomic Energy Authority's commitments.

Returning to the fast reactor: this has been designed

The fast breeder reactor sphere is 135ft in diameter and fabricated from steel plates varying from 1in to 1⅞in thick



as an experimental breeder reactor which will utilise enriched U235 or plutonium as fuel in the core and the relatively plentiful U238 or thorium as fertile material in the blanket. More fissile material will be formed in the breeding blanket than will be "burned" in the reactor core. The source of power in the fast reactor is the fission of U235 and U238 in the core. Since the fast neutron chain reaction cannot be sustained in natural U238 the fast reactor core contains a higher proportion of U235. The reactor core, in which 60 MW of heat can be generated, is a 21in right cylinder containing niobium sheathed uranium rods, arranged vertically in a closely packed array. Surrounding the reactor core is the breeder consisting of about 2,000 rods of natural uranium arranged vertically, each rod being 8ft long and 1¼in in diameter.



Schematic arrangement of the fast reactor plant

The reactor core and breeder are housed in a stainless steel pot, known as the reactor vessel, 10ft 6in in diameter and 20ft long. Into the top of the reactor vessel is pumped the liquid sodium-potassium coolant which flows down over the core and breeder, removing the heat generated by fission and transferring it to a series of concentric tube type heat exchangers situated inside the reactor vault. The reactor vault is a concrete structure in the reactor sphere. It supports the reactor vessel and houses all the heat exchangers and coolant pipework associated with the primary cooling of the reactor core and breeder.

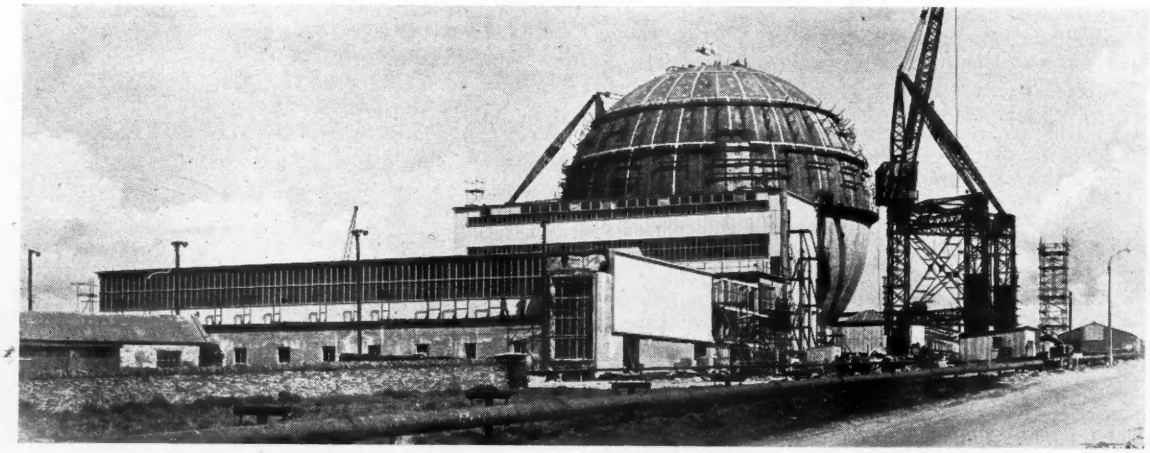
Heat is transferred from the primary liquid metal coolant to liquid metal in a secondary coolant circuit in the concentric tube heat exchangers. The secondary coolant then passes out of the reactor sphere in stainless steel pipes to the heat exchanger building. Here the heat in the secondary liquid metal coolant is transferred to water in a set of copper-bonded heat exchangers of novel design. The steam produced will eventually be used to drive a 15 MW turbo-alternator in the turbine hall at the rear of the heat exchanger house.

A building adjacent to the heat exchanger house contains electrical equipment and switchgear primarily for instrument supplies. Another structure accommodates two groups of diesel generator sets, one of which supplies power to all pumps and equipment in the main reactor cooling circuits. The second group of diesel sets serves as standby.

On the sea coast about 100 yd from the reactor is the sea-water pump house in which there are four diesel-driven pumps for providing cooling water for the condenser of the 15 MW turbine and also for cooling auxiliary plant in the heat exchanger house. The reactor is controlled from a room situated at the end of the administration building. At the rear of the administration building is the element storage building in which new fuel elements are stored and irradiated elements are handled before going into the cooling pond.

The reactor sphere is now a well-known landmark in the Caithness area and it is one of the largest pressure vessels ever to be built. It is 135ft in diameter and is constructed from mild steel plate varying in thickness between 1in and 1⅞in. All the steel plate used was cold pressed hydraulically into shape before being welded. The sphere has a surface area of about 1½ acres and weighs over 1,500 tons; the total length of welded seam is over two miles, and the whole of this has been radiographically inspected.

General view of the fast breeder reactor with the associated powerhouse in the foreground



The sphere serves two purposes. First, it will prevent the spread of fission products formed during reactor operation, should they be accidentally released within the sphere. Secondly, it has been designed to withstand any pressure variations that might occur as a result of a liquid metal fire within the sphere. Such an occurrence should not increase the pressure inside the sphere by more than 18 lb/sq in or reduce it by more than 3 lb/sq in. Access to the sphere is through an air lock 40ft long and 16ft in diameter with airtight doors at each end. The air lock permits entry to the sphere via the adjacent element storage building at the level of the mid-point of the sphere.

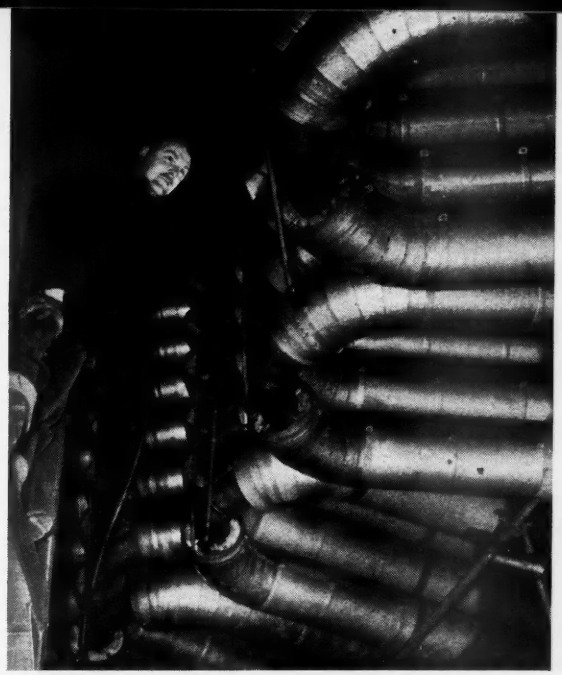
To prevent any radiation hazard inside the reactor sphere the reactor and primary coolant circuits are contained in a concrete biological shield known as the reactor vault. This is in the form of a bowl 90ft in diameter and 45ft high with 5ft thick walls. The roof slab has a central hole immediately above the reactor vessel. Further shielding is provided around the reactor vessel to prevent the secondary liquid metal coolant and the pipework within the reactor vault from becoming radioactive. This shielding consists of a 4ft layer of borated graphite in which an equatorial region of pure graphite permits fission rate measurements to be taken.

The fast reactor core consists of fissile material, in which the majority of the fission processes occur, surrounded by a "blanket" of fertile material which serves to reflect neutrons back into the core as they try to escape and in which fresh fissile material is generated. The main heat generation occurs in the central portion, the core proper, which is a hexagonal prism 21in high and 21in across the flats, made up of several hundred fuel elements of annular cross-section. Each contains, at either end, a length of natural uranium which acts as blanket or breeder material. The blanket is completed by surrounding this central portion with about 2,000 natural uranium rods 8ft long and 1¼in in diameter.

When the reactor is operating at its designed power output, the 60 MW of heat generated is removed by the liquid metal heat transfer medium which also cools the blanket. This liquid metal flows down between the fuel elements and blanket elements, and down the inner tubes of the fuel elements. Each element is positioned in, and supported by, the stainless steel bottom plate of the reactor, while adequate space for the flow of the liquid metal coolant between the elements is maintained by the fins on each outer can.

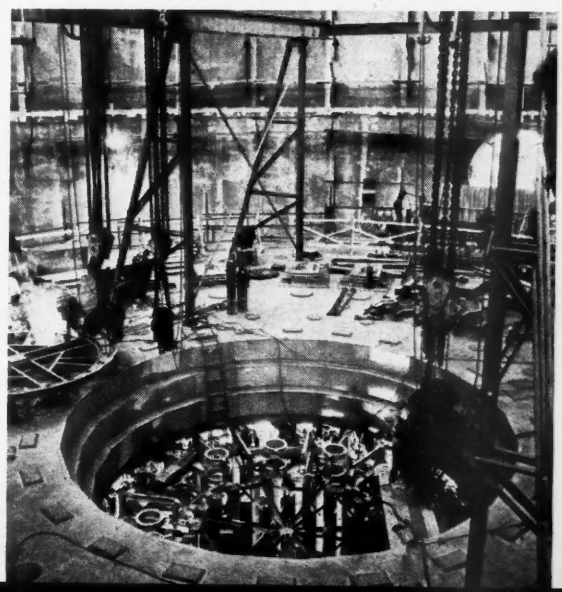
The fuel and blanket elements are canned in niobium and stainless steel respectively to contain the fissile material and fission products and to give dimensional stability to the core and blanket lattice. Niobium has a high melting point and a good resistance to hot uranium and sodium. Stainless steel is used for canning the blanket elements, since the conditions are less severe, but it is worth noting that these "less severe" conditions are, in the case of the blanket elements nearer the reactor core, more severe than those experienced by thermal reactor fuel elements.

The neutron flux, and, therefore, the heat generated in the core, is controlled by moving groups of fuel elements into and out of the core, the former movement giving increased reactivity. The fuel elements used for this purpose are identical with those in the normal reactor charge. The essential feature of this fast reactor is that it is an experimental tool, and for this reason it has been designed so that minor and major components may be easily replaced if different component designs have to be tested. This interchangeability is so great that the whole assembly within the double-walled reactor vessel can be removed and replaced if this is desired.



Some of the 24 primary heat exchanger banks used to extract the 60 MW of heat produced in the core and blanket of the fast breeder reactor

One of the electromagnetic pump units which are used to circulate the liquid metal coolant and (below) work proceeding on the installation of the core and primary heat exchangers inside the reactor vault



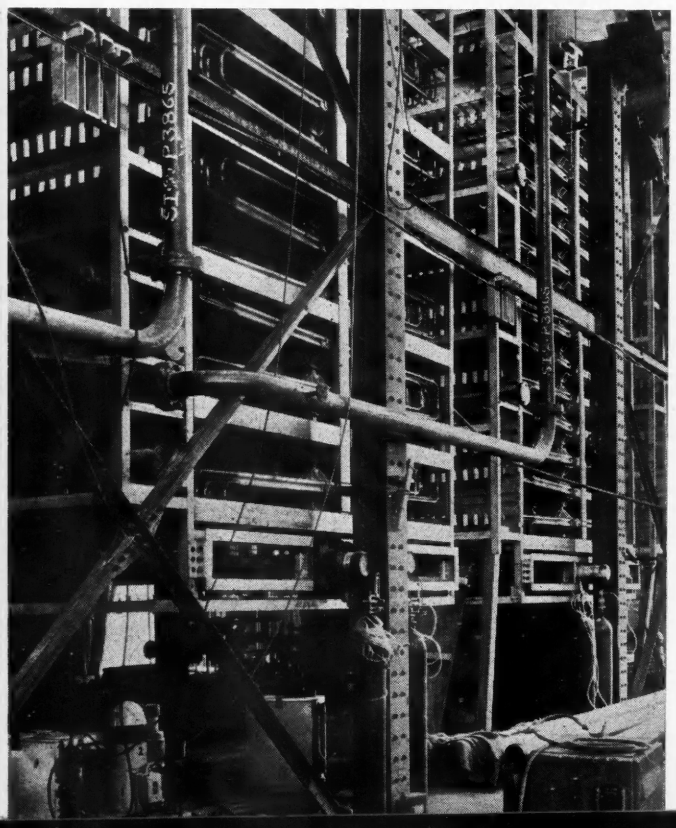
The liquid metal to be used initially for heat removal is an alloy of sodium and potassium. It becomes radioactive on passing through the reactor, and it is also contaminated by fission products so that it must be contained within the concrete biological shield. Its heat is therefore transferred to liquid metal in a secondary system. This secondary liquid metal carries the heat through the biological shield and out of the sphere to the heat exchanger house, where the heat is given up in a steam raising plant. Any steam generated in excess of the turbine requirement spills automatically into dump condensers which are cooled by sea-water and have sufficient capacity to absorb the full reactor heat output if the turbine is not running.

The liquid metal is circulated by electromagnetic pumps having no moving parts, the only maintenance required being upon the insulation of the windings. The windings can be removed without opening the liquid metal system; in the primary system this is done by remote operation through the biological shield. The system contains no valves, or any other parts requiring mechanical maintenance.

Complete failure of the heat removal plant would very quickly result in the overheating of the reactor, and to prevent such a failure the heat removal is shared among twelve independent and identical units. A unit comprises two primary liquid metal circuits, one secondary liquid metal circuit, a steam raising plant and a dump condenser. Each unit has an independent electrical supply from its own diesel alternator so that the risk of a large-scale electrical failure is remote.

If, in spite of the above precautions, a widespread failure of heat exchange plant occurred, it would not be sufficient to shut down the reactor, because some heat would be generated by fission product activity after shutdown. A thermal siphon system of heat removal is provided which uses no electrical power but relies solely on convection effects to dissipate heat to the atmosphere. Convection causes a circulation in the primary liquid metal system from which heat is transferred to liquid metal in the thermal siphon system. This liquid metal is also circulated by convection and transfers its heat to the atmosphere through heat exchangers in the stack. The system also dissipates a certain amount of heat during normal running.

Banks of secondary heat exchangers for transferring heat from the liquid metal to water



The heat exchangers which transfer heat from the primary coolant circuits to the secondary circuits are all of tube and annulus design. Since the liquid metal reacts violently with water, the steam raising exchanger has been designed to prevent leaks from one side to the other. Stainless steel tubes carrying the liquid metal and the water are bonded in a common copper matrix which allows a leak of either fluid to escape to atmosphere. Apart from the heat exchangers, the twelve steam raising plants are similar in design to conventional forced circulation boiler systems.

Fuel elements in the reactor must be periodically discharged, because, first, prolonged irradiation causes physical distortion of the elements and, secondly, the fuel element efficiency falls with the depletion of the fissionable material and the build-up of fission products in the element. Similar considerations apply to a lesser degree for the breeder elements. The elements are therefore removed periodically from the reactor in shielded containers and placed in the cooling pond to await chemical processing. New or refabricated elements are loaded into the reactor in their place.

Removal and replacement of elements is carried out by the charge machine. This machine is lowered on to a seal door on the rotating shields above the reactor vessel, and elements can be moved vertically into or out of the reactor. The machine is heavily shielded to avoid any radiation hazard to operators. Embodied in the machine is a cooling system for removing residual heat from the elements after withdrawal from the liquid metal. At the base of the machine a gas-tight door is fitted and this is interlocked to ensure that it and the corresponding seal door on the rotating shields are closed before the charge machine can be removed from the rotating shields, thus preventing direct escape of blanket gas into the sphere. When an irradiated element has been raised into the charge machine the latter is transported by the large rotary crane above the reactor vault to the canning station alongside.

Reprocessed elements are returned from the chemical plant to a store in the element storage building. When required for use the elements are put into a stainless steel can filled with inert gas and raised into the canning station in the sphere. The charge machine having discharged an irradiated element into the canning station now reloads with a reprocessed element and is transported to the rotating shields where the reprocessed element is lowered into the reactor.

Control of the fast reactor is achieved by moving parts of the core. Twelve groups of fuel elements situated at the corners of the core hexagon form the control rods which may be moved into or out of the core. These fuel elements are held in a metal frame resting on a support arm within the liquid metal, enabling the control rods to be raised into the core to increase its reactivity or dropped below the core to shut the reactor down. A magnetic clutch is incorporated in each control rod drive to allow the drive to be transmitted through the reactor vessel without leakage of fission products. Each control rod and support within the reactor vessel is supported by an electromagnet, so that interruption of electrical supply to the electromagnets allows the rods to fall rapidly out of the core thereby shutting down the reactor.

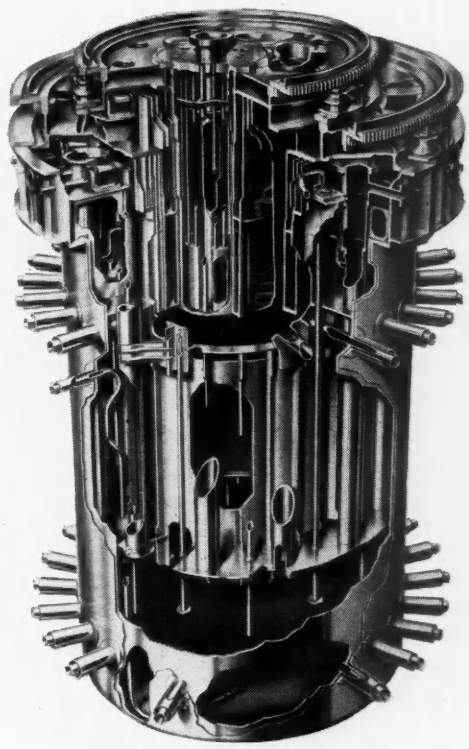
As all the twelve control rods are of identical design

it is possible that a common fault could develop in the mechanism which could prevent their satisfactory operation in an emergency. To provide a reserve control enabling the reactor to be shut down under these abnormal conditions, three rods containing neutron-absorbing boron may be dropped into the inner row of breeder elements surrounding the core. The design of these boron safety rods differs from that of the control rods, so that the possibility of their failure at the same time as that of the control rods is remote.

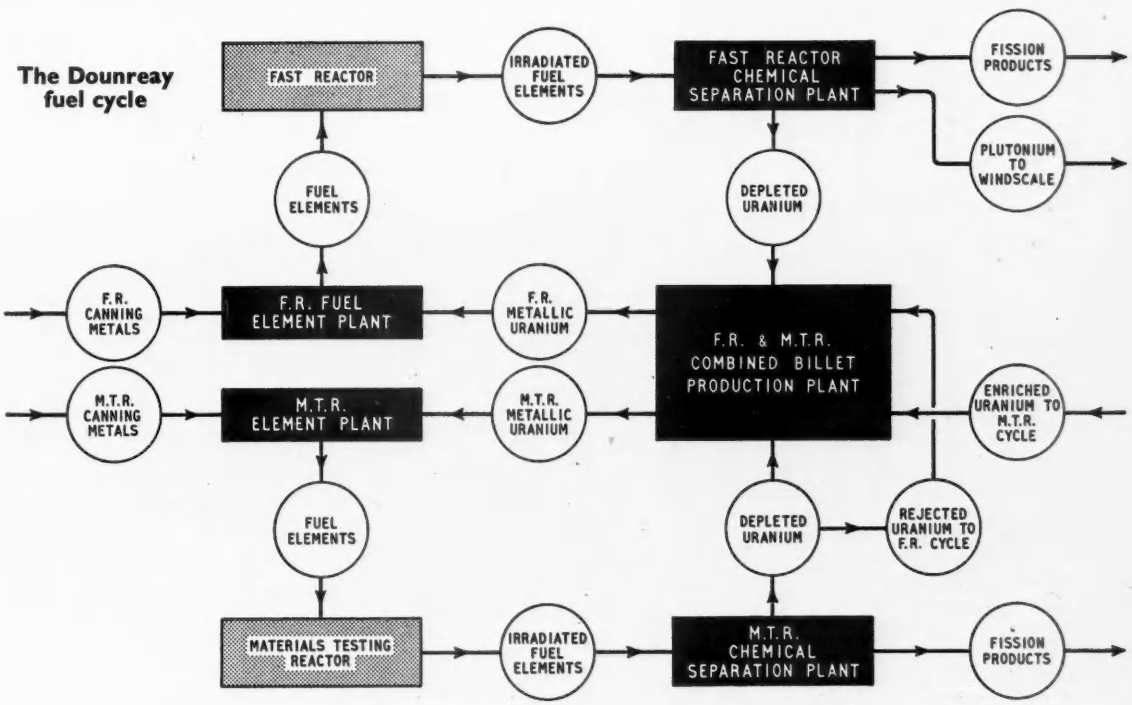
The positioning of the control and safety rods is controlled from the desk in the control room by means of a selector switch and push-buttons. Operation of an emergency push-button on the desk cuts the current to all the "hold-on" electromagnets and drops all the control rods and boron safety rods simultaneously. In addition to normal or emergency shut-downs controlled by the operator from the control desk, automatic shut-down occurs in the event of failure of pressure in the primary gas blanket, high temperature in the centre of the core, low flow of liquid metal coolant through the core and breeder, a high level of neutron flux, or an abnormally rapid rate of increase of neutron flux. Electromagnetic flowmeters measure the flow of liquid metal coolant in the primary and secondary circuits, and the nuclear behaviour of the reactor is followed by ion chambers in the graphite shield around the reactor vessel.

All operations involving a change in reactivity are controlled from the desk in the control room. Here are the switches and push-buttons enabling the power of the reactor to be varied by adjustment of the control rods, and here also are the controls determining the rate at which liquid metal is pumped through the coolant circuits. The instruments indicating or recording the behaviour of the reactor and its heat extraction circuits are grouped on the outer instrument panels.

As already mentioned, the fast reactor is a power-producing plant capable of feeding 15 MW of electricity into the grid. It must be borne in mind, however, that



Exposed section of the main vessel containing the fast breeder reactor



it is primarily a pilot plant and an instrument of research, and it is not to be expected that the reactor will produce this amount of electricity continuously, especially during the early stages. Initially, the turbine stop valve steam conditions will be 150 lb/sq in and 518 deg F, but it is anticipated that at some time in the future these figures will be raised to 200 lb/sq in and 622 deg F.

The reactor needs to be supplied with some electricity, for pumps, heaters, instruments, lighting, etc. Some of this will be taken from the grid, and some will be generated in a power house on the fast reactor site. The reactor is cooled by twelve independent cooling units, and the electrical equipment which serves each of these units is on an individual circuit fed by its own 120 kW diesel-alternator set. In addition, there are six further alternators of the same capacity standing by, and in the event of failure of one of the twelve, the appropriate standby set can be quickly brought into circuit.

The remaining electrical requirements of the reactor may be divided into three main groups, depending upon the consequences of a failure: (1) plant, in which a failure of the electrical supply would cause the reactor to shut down, (2) instruments, in which a failure would mean that the operators would have no knowledge of what was happening within the reactor, and (3) other factory services, in which a failure would have no immediate effect on the running of the reactor.

After transforming the grid voltage to 415 V it is fed into a busbar. Six 220 kW diesel-alternators are standing by to feed into this busbar in the event of grid failure. From this busbar, the current is transformed (and rectified where necessary) to suit the electrical plant. Where a break in the continuity of supply is inadmissible, i.e. categories (1) and (2) above, d.c. is used and batteries are connected to the circuit to provide a reserve supply while changing over from grid to diesel-alternators.

Materials Testing Reactor

To speed research into problems associated with the design and construction of reactors planned in the development of the nuclear power programme, a materials testing research reactor is being constructed at Dounreay. It is designed to enable materials of construction, fuels and their canning materials, coolants and heat transfer media to be irradiated in its neutron flux under specific design conditions which can be related to those in a full-scale power producing reactor.

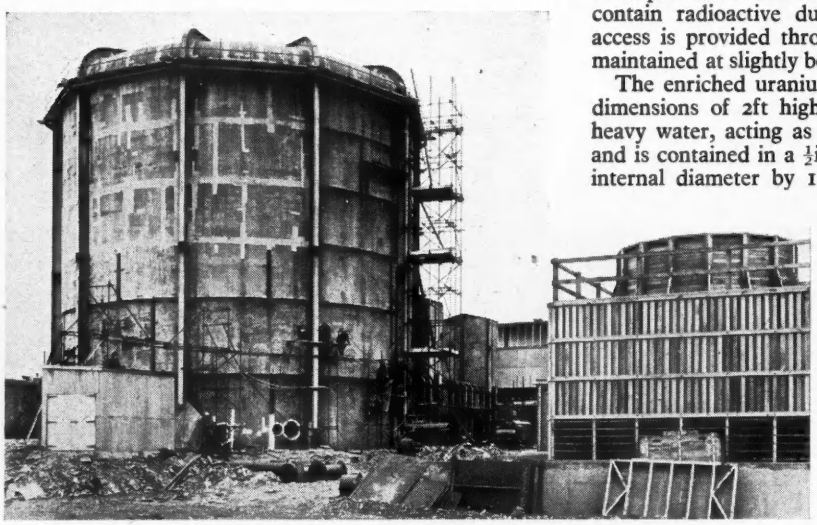
The graphite reflector of the materials testing reactor. This is in a steel tank which is in turn surrounded by concrete shielding

The method of testing materials is to incorporate them into " test rigs " which in turn are inserted into the reactor and irradiated to the required degree. The test rigs are then removed and dismantled and the test materials are subjected to their appropriate examinations. Since the reactor has a high neutron flux, research work previously requiring a long period of irradiation due to lack of large neutron sources can be completed in a much shorter time.

The reactor is an enriched uranium, heavy water moderated and cooled thermal reactor with a peak flux of 10^{14} thermal neutrons per cm^2/sec at a total output of 10 MW. It is similar to DIDO, inaugurated at Harwell last November, but with the major difference that the experimental facilities are fewer but are designed for large engineering test rigs.

The reactor hall is a cylindrical steel building 70ft high and 70ft in diameter which houses the reactor, its control room and main auxiliaries and space for the conducting of experiments around the reactor. It is designed to contain radioactive dust in the event of an accident; access is provided through air locks and air pressure is maintained at slightly below atmospheric.

The enriched uranium core of the reactor has overall dimensions of 2ft high by 2½ft by 3ft, is immersed in heavy water, acting as moderator, reflector and coolant, and is contained in a ½in thick aluminium tank of 6ft 7in internal diameter by 11ft high. It is surrounded by a thick graphite reflector which is itself contained in a steel tank, ⅝in thick, 8ft 9in internal diameter and 12ft high; this has a ½in thick boral lining and a 4in thick lead lining, acting as a gamma-ray shield. A 5ft thick,



General view of the heavy water moderated materials testing reactor

218 lb/cu ft concrete biological shield encloses the tank. The top shield is 4ft 4in thick of iron-shot concrete with a density of 350 lb/cu ft. The heavy water is 6ft deep and is blanketed with helium. At 10^{14}n/cm^2/sec peak core flux the fission heat is 10 MW.

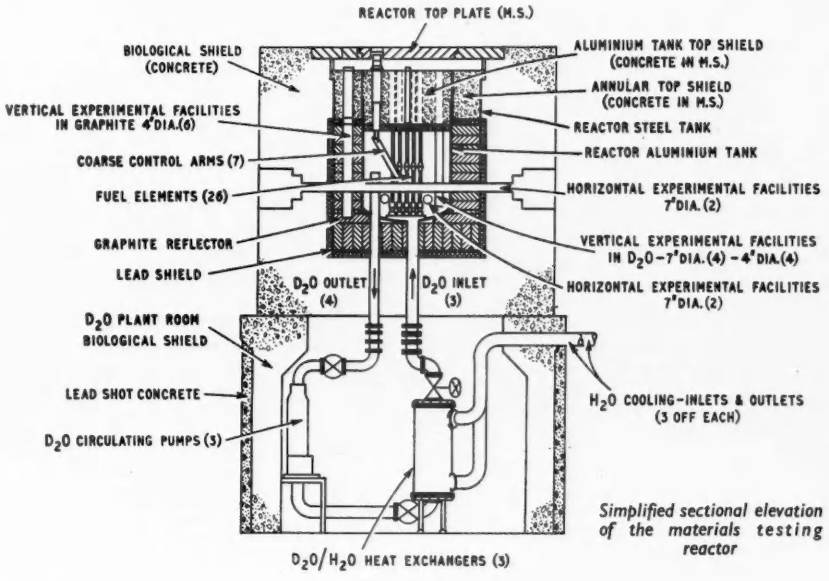
There are 26 fuel elements in the core, arranged in a 6in square lattice in a 5×6 array, with corners unoccupied. Each fuel element consists of ten curved plates of aluminium-clad, uranium-aluminium alloy, 0·058in thick and 0·177in apart. The ten plates form an element 2·88in by 2·53in by 25in long. The heavy water coolant flows at 11·3 ft/sec past the fuel element at 11·5 lb/sq in inlet pressure, and 44 deg C inlet and 51 deg C outlet temperatures.

There are seven signal-arm type controls, suspended at 1ft intervals along both 3ft sides of the core, at 19·6in from the centre vertical plane, and they operate downwards from a fully-out horizontal position over a 60 deg arc, controlling up to 25 per cent reactivity. Each arm contains a 2 mm thick by 6¼in by 42in strip of cadmium, enclosed in stainless steel and weighing 26 lb. The normal operating time for the full 60 deg movement is 24 min but an emergency free fall takes less than 1 sec. In addition, there is a vertical fine control rod governing ¼ per cent reactivity, situated at an unoccupied corner of the core. It consists of a 2 mm thick cadmium sheet formed into a $\frac{9}{16}$in o.d. 24in long tube sandwiched between two stainless steel tubes, the full 24in travel taking 15 sec. Two safety rods are also provided in diagonally opposite corners, formed of similar cadmium sheet into a $1\frac{3}{8}$in o.d. 30in long tube sandwiched between two aluminium tubes.

Three totally submersible 60 h.p. pumps (one standby) deliver the required 4,800 gal/min of heavy water to the core and the 10 MW of heat is removed in three stainless steel heat exchangers to light water. The heavy water is continuously sampled at three points for purity, conductivity and pH. Four pumps, one of which acts as standby, circulate the water from the heat exchangers to cooling towers, the make-up of evaporation requiring 81,000 gal/day of treated water. The pressure is kept below that of the heavy water, so that leaks will be out of the heavy water circuits.

The efficiency and economy of atomic reactors as power-producing units depends finally upon the provision of materials possessed of the necessary physical and mechanical properties, corrosion resistance and dimensional stability at high temperatures and under irradiation. Under bombardment by fission product particles, neutrons, and alpha, beta and gamma radiations, materials may suffer considerable changes in their normal physical and chemical behaviour. Interactions with the electron shells of atoms may cause them to become highly ionised and reactive with otherwise inert materials. Corrosion by water and CO_2 tends to be accelerated under irradiation in this manner. Conversely, reactions normally occurring may be suppressed, and natural corrosion processes be inhibited in the presence of irradiation. As a result of collisions with fission particles, atoms may be displaced from their normal positions on their crystal lattice, and the sub-microscopic processes leading to diffusion, conduction and deformation so distorted as to bring about large changes in the mechanical and physical properties of the material. In the case of uranium fuels, the high flux of fission particles at high energies allied to the complexity of

The aluminium reactor tank of the materials testing reactor


REACTOR TOP PLATE (M.S.)
BIOLOGICAL SHIELD (CONCRETE)
ALUMINIUM TANK TOP SHIELD (CONCRETE IN M.S.)
ANNULAR TOP SHIELD (CONCRETE IN M.S.)
VERTICAL EXPERIMENTAL FACILITIES IN GRAPHITE 4"DIA.(6)
REACTOR STEEL TANK
REACTOR ALUMINIUM TANK
COARSE CONTROL ARMS (7)
FUEL ELEMENTS (26)
HORIZONTAL EXPERIMENTAL FACILITIES 7"DIA.(2)
GRAPHITE REFLECTOR
VERTICAL EXPERIMENTAL FACILITIES IN D2O-7"DIA.(4)-4"DIA.(4)
LEAD SHIELD
D2O OUTLET (4)
D2O INLET (3)
HORIZONTAL EXPERIMENTAL FACILITIES 7"DIA.(2)
D2O PLANT ROOM BIOLOGICAL SHIELD
LEAD SHOT CONCRETE
H2O COOLING-INLETS & OUTLETS (3 OFF EACH)
D2O CIRCULATING PUMPS (3)
D2O/H2O HEAT EXCHANGERS (3)

Simplified sectional elevation of the materials testing reactor

the uranium crystal structure produces most striking effects which can be observed visually in changes of shape and volume, as well as by determination of mechanical and physical properties.

Specification of materials for reactors so far constructed has been based, inevitably, upon data gained during exhaustive tests conducted out-of-pile. Experience gained in the operation of these reactors, and experiments carried out in them, has yielded valuable information on the effects of irradiation. Of necessity, however, these reactors were designed to work at moderate levels of temperature and neutron flux. With the provision of research reactors at Dounreay and Harwell, it now becomes possible to subject materials to specific conditions of temperature and neutron flux. Materials may receive in a comparatively short period the irradiation dosage equivalent to that received during their service life in a power reactor.

In drawing up the experimental programme, highest priority is awarded to those projects which will provide the maximum information to the design teams of the Industrial Group of the U.K.A.E.A., and their collaborators in the commercial field. A minimum of six holes has been allocated to studies of the behaviour of different types of fuel under various conditions of temperature, stress, and " burn-up " rate. Information will be gained on the tendency of the fuel to grow or swell under irradiation, changes in thermal conductivity, hardness, mechanical strength and metallurgical structure, and the ability of various types of can to restrain the deformation of the specimen. At the completion of these tests it should be possible to state not only the best fuel composition or structure for a given set of conditions, but also, perhaps, the length of time for which it may safely be irradiated, and the most suitable material in which to contain it. A further hole will be used for proving tests on fuel elements designed for commercial reactors, together with their supporting structures, in which the performance of the forms of fuel element prescribed for C.E.A. reactors can be demonstrated.

Three large holes will be available for research into the effects of irradiation on the corrosion properties of coolants such as Na, NaK, CO_2 and H_2. Smaller facilities will be set aside for specialised problems of irradiation chemistry and for the development of analysis techniques dependent upon the formation of radioactive isotopes.

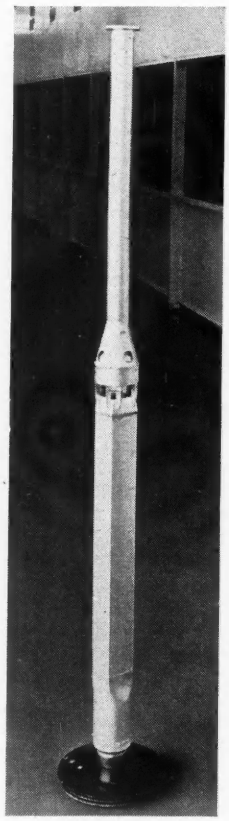
The behaviour of graphite under irradiation is of such fundamental importance in thermal reactor design that investigations on this subject alone will occupy one or two holes. The remaining facilities will be devoted to measurement of the mechanical and physical properties of structural materials such as alloys of the rarer metals, beryllium, zirconium, niobium, molybdenum and magnesium of interest as container materials, and also various types of steel used in pressure shells and support structures. Studies will include the post-irradiation examination of irradiated material, and measurement of properties such as tensile strength, creep resistance, thermal and electrical conductivity and thermal expansion on specimens during irradiation.

It must be stressed that the irradiation programme represents only the final phase in a research programme of some magnitude. Irradiation tests are expensive, and the demand far exceeds supply. Hence the other laboratories of the Industrial Group have already investigated numerous problems appertaining to the preliminary selection of materials for reactor use, and only those materials meriting further consideration will be passed forward to the irradiation testing stage. At the same time it must be emphasised that the maximum value is to be obtained from irradiation experiments only if parallel experiments are carried on out-of-pile, and the effects due to irradiation alone abstracted. For this reason the function of the Dounreay materials testing reactor research group will not be limited to the design and conduct of experiments in the reactor. An essential corollary will be the simulation of in-pile conditions—less neutron flux—in the laboratory, to obtain the datum line against which the results of in-pile tests may be compared.

The Chemical Group

The Dounreay Chemical Group consists of four main sections which are respectively concerned with fuel element fabrication, chemical separation and billet production, effluent disposal, and chemical analysis. In the fuel element fabrication section there are two distinct processes. In the first one enriched uranium metal is made into fuel elements for the fast fission reactor. In the second, fuel elements for the materials testing reactors at Dounreay and Harwell are manufactured from highly enriched uranium.

The irradiated fuel elements from the fast reactor are dissolved in nitric acid and by means of a solvent extraction process the uranium is separated from fission products and plutonium. The pure uranium, in a solution of nitric acid, passes to the billet plant where it is converted to metal by metallurgical processes. The billets of pure uranium metal are then returned to the fuel element fabrication plant. A similar process is used to deal with irradiated fuel elements from the materials testing reactor.



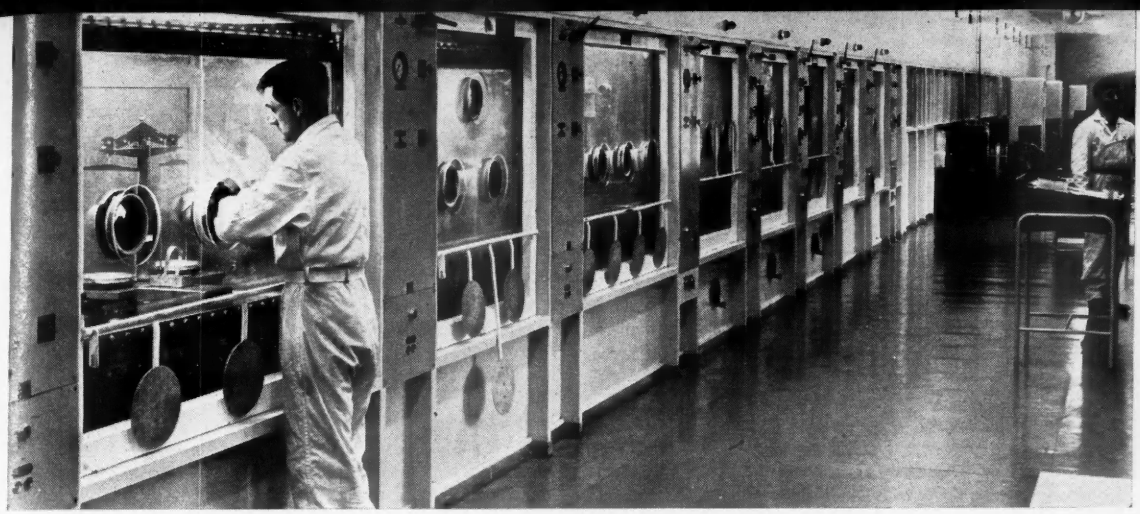
Completed fuel element assembly containing enriched uranium

The disposal of radioactive effluent from the chemical plants is an important function of the Chemical Group. Highly active waste products from the chemical separation processes are stored indefinitely in underground storage tanks. Waste of very low activity is diluted and at high tide is pumped out to sea along an underground pipeline. The tidal current disperses it and it becomes highly diluted in the sea.

The chemical analysis laboratory is the control building of the Chemical Group. Here samples of materials taken from all stages of the chemical separation plants and fuel element manufacturing processes are analysed as a check on the efficient and economical operation of these plants.

Responsibility for experimental work within the Industrial Group of the Authority rests with the Research and Development Branch. Since Dounreay is an experimental establishment, the Research and Development Branch will determine the experimental programme for the development of the fast reactor and the utilisation of the materials testing reactor.

An extensive study of the nuclear and thermal characteristics of both reactors will commence in the com-



Part of the Dounreay fuel element production line

missioning stage and, in the case of the fast reactor particularly, will proceed continuously with the development programme. Neutron flux, the effect of control systems on reactor power, and the effect of prolonged irradiation of fuel elements on neutron behaviour will be studied. In the case of the materials testing reactor, flux depression caused by the presence of experimental rigs and specimens will be measured.

The development of new and improved fuel elements for the fast reactor involves both new fuel materials and rare metals which may have application in this type of reactor. Studies of preparation, fabrication, measurement and inspection of these materials, with methods of assembly to strict limits, will be a major part of the work.

Irradiation testing in the materials testing reactor involves careful design of experiments to ensure that accurate and reproducible data are obtained. Control of conditions during the tests, and assessment of phenomena due to neutron and other radiations, may involve inactive testing in a separate laboratory simultaneously with reactor work.

Following irradiation of fuel elements in the fast reactor and specimens in the materials testing reactor, an exhaustive examination, rendered difficult by the necessity for heavy shielding, will ensue. Dimensional checks, macroscopic and microscopic examination and measurement of physical and mechanical properties will be carried out initially on the complete component, and later, after breaking down, to a finer degree on small specimens.

The effect of irradiation on chemical substances and their reactions, particularly where materials of construction for reactors or associated processing are concerned, will form one feature of the duties of the Chemical Group.

The use of fissile material in manufacturing processes before and after irradiation in a reactor requires supervision to avoid a "critical" assembly. Experimental work to study the approach to a critical mass of a wide variety of materials under unusual conditions of dispersion is being carried out. Extension of this type of experiment to the behaviour of reactors in unusual circumstances is under consideration.

Much of the work described above requires a strong engineering group to design, supervise construction, and thoroughly test, the experimental apparatus and measuring gear. Development of new and improved remote handling mechanisms for irradiated material is a particularly important function of this group.

Some long-term research and development work, associated with Dounreay, will also be undertaken by the laboratories, chiefly in the fields of physics, metallurgy and chemistry. The Dounreay establishment also includes a health physics and safety department which provides services to all other works groups in respect of all aspects of radiation and industrial safety.

At present all the electrical supplies for the Dounreay establishment are provided by the North of Scotland Hydro-Electric Board. A double circuit 132 kV line brings the supply from Loch Shin to Mybster where it is transformed down to 33 kV. From Mybster two 33 kV lines feed out on a ring main system, one side of the ring being a direct feed to the Hydro Board 33 kV substation at Dounreay. From this substation the 33 kV supply is taken by cables to two transformers, situated near to the main factory substation, where the supply is transformed down to 11 kV. From the main factory substation 11 kV cables feed out on a ring main system to supply two more substations at the north side of the factory. At these three 11 kV substations the supply is transformed down to 415/240 V and the supplies are then taken to the various factory buildings. In the event of a failure of the Hydro Board supply, standby diesel plant is available. The 15 MW turbo-alternator will feed into the main factory substation where it will be connected to the Hydro Board system.

Over 600 contracts have been placed for the manufacture or supply of plant, equipment, materials, etc., for the Dounreay establishment. Among the principal firms involved are Whatlings, Ltd., main building and civil engineering work; Motherwell Bridge & Engineering Co., Ltd., fast reactor sphere and sealed steel building for materials testing reactor; Alex Findlay & Co., Ltd., structural steelwork; T. W. Ward, Ltd., process pipework; Head Wrightson & Co., Ltd., internal erection of testing reactor; Matthew Hall, Ltd., steam and compressed air mains, condensate runs, and heating and ventilation; John Thompson Water Tube Boilers, Ltd., internal work of sphere and heat exchangers, also associated steam and water equipment; Glenfield & Kennedy, Ltd., electrically-operated valves; English Electric Co., Ltd., electromagnetic pumps; James Scott & Co., Ltd., electrical installations; Crossley Brothers, Ltd., diesel generating plant; Brush Electrical Engineering Co., Ltd., frequency changers; Costain-John Brown, Ltd., installation and commissioning of instrument panels; Evershed & Vignoles, Ltd., level transmitters and indicators; Laurence, Scott & Electromotors, Ltd., motor-alternator equipment; Metropolitan-Vickers Electrical Co., Ltd., mass spectrometer and h.f. heating equipment; A. Reyrolle & Co., Ltd., switchgear; Simmonds Aerocessories, Ltd., control rod position indicators; General Electric Co., Ltd., furnaces and turbo-alternator equipment; Bruce Peebles & Co., Ltd., external equipment for diesel generators.

BRITISH INDUSTRIES FAIR

WITH the absence of so many of the leading electrical firms from this year's British Industries Fair at Castle Bromwich, it was perhaps only to be expected that the electrical display would be on a small scale, but just how sparse the actual display is can be judged by the fact that only four companies generally recognised as electric motor manufacturers are represented, compared with 25 or so at the recent Electrical Engineers' Exhibition, while the number of stands that display cables and accessories is less than a dozen. The Fair is still divided into four groups: hardware, building and heating, electrical and engineering, but the electrical section is much smaller than in any previous year and includes several stands that are not in any way connected with the industry. One such display in this section is that of the East and West Midlands Gas Boards.

Industrial Heating

The general theme of the display in both the electrical and engineering sections appears to be diversity of applications, showing what the electrical industry can do to help other industries perform their tasks more efficiently and easily. Some of the more interesting examples of the use of electric heating in industry, many in actual operation, are to be seen on the stand organised jointly by the British Electrical Development Association and the Midlands Electricity Board. These include resistance, dielectric and induction heating as applied to industrial processing, glass tube bending, paint drying, timber seasoning, die-casting and metal melting. Overhead infra-red heaters, off-peak block storage heaters and underfloor warming, are all means of heating factories electrically and a section of the stand is devoted to showing these various methods.

Among the motor exhibits Higgs Motors, Ltd., on their stand, draw attention to their range of machines built to the new draft B.S. for 3-phase motors with ventilated enclosures, CW (ELE) 6246, and show their new range of f.h.p. motors including split phase, capacitor start and repulsion induction single-phase types, together with polyphase and d.c. machines. During the past twelve months, one or two new developments have been made to their geared motor units and a full range is shown. Also on view are standard and industrial motors and generators including flange and vertical mounting types, stator and rotor units, and loom and polishing motors, all part of a comprehensive range, from $\frac{1}{8}$ to 1,000 h.p. which the company manufactures at its Witton Works. The selection of drip-proof and fan-cooled motors which Brook Motors, Ltd., have on view, includes two items recently introduced which are interchangeable with the existing range: a fan-cooled slip-ring motor with internal rings, and a crane motor in either cage or slip-ring type. The company's single-phase "Power Pack," a complete low priced unit intended mainly for agricultural machine driving consisting of a protected or fan-cooled motor with either hand-operated or automatic push-button starter, is also shown. Among their other exhibits are control gear, hand-operated and automatic push-button starters, and a comprehensive range of push-button stations and limit switches.

The Brooks D.P.C. Machine Co. shows a damp-proof course cutting machine for the building trades. It is claimed that damp-proof course repair work that previously took a week to complete, can now be finished in a day with little physical effort. A new membrane can be inserted into an existing wall at the rate of 60-80ft with two men in an 8-hour day. The "Major" machine will cut into the mortar joint or brickwork to a depth of 5in maximum, while the "Senior" unit is used primarily for cutting corners after the "Major" has cut as far as it can operate. It can also be adjusted to operate cutting the mortar joint in 9in and 14in walls. The machine is driven by a 2 h.p. single-phase motor, specially designed with a low starting current for use on a domestic supply, and controlled by a robust starter.

Increasing use is being made of electronic techniques to achieve results which are unattainable by other methods. A new electronic device which will greatly simplify colour printing processes, is shown for the first time by Hadley Telephone & Sound Systems, Ltd. Colour reproduction, in print or photographic form, can be a slow and costly business, but a considerable saving in time is claimed for the "H.P.K. Autoscan," best described as a reproduction camera with electronically controlled light output for scanning coloured copy and producing colour and tone corrected separation negatives. Southern Instruments, Ltd. (Oscillograph Division), are also exhibiting at the Fair and among oscillograph recording equipment and other electronic equipment on view, is a type ME 122 two-channel engine indicator. This equipment provides means of indicating two simultaneous variables on any i.c. engine or compressor, using either variable capacitance, resistance, electro-magnetic or photo-electric pick-ups. Diagrams can be obtained of any cylinder or pulsating pressure, and measurements can be made with strain-gauges, vibration pick-ups or accelerometers.

Of special interest on the stand of C.J.R. Electrical & Electronic Development, Ltd., is a slow-speed magnetically-operated sequence and slip controller with operating speeds from $7\frac{1}{2}$ to 15 and 15 to 30 r.p.m. In this system there is no direct connection between the driving shaft and the impulse unit, the coupling between the two being carried out magnetically.

Samples of assemblies made on printed circuit board are shown alongside their counterparts manufactured by the older wiring methods on the stand of Technograph Electronic Products, Ltd. The company has developed a technique of flush bonding the contact surfaces of the digitiser plates and commutating devices so that a smooth track is obtained for any brushgear and examples of different finishes are shown, such as silver and rhodium for switch contact. Applications for instrument engineering include foil type resistance strain gauges of various patterns and temperature sensitive elements.

Conveying Equipment

Materials handling and conveying equipment is represented on the stand of Universal Conveyors, Ltd., who have on view a wide range of electrically operated flat belt conveyors. Shown for the first time is a prototype of a belt conveyor which turns a corner. Although there are wire mesh conveyor belts and also slat and chain conveyors which turn corners, the makers state that these have limitations compared with belt conveyors. Little other information is available at the moment but it is understood that it will be in the market in the very near future in various belt widths and different angles. A new lightweight stacker shown by Lodematic, Ltd., is of compact telescopic design and measures only $2\frac{1}{2}$ft wide. Its hydraulic system is powered by an electric motor or small petrol engine and incorporates a relief valve of automatic type to guard against excess weight. No-volt release and

thermal overload protection devices are incorporated in the electric models. Lansing Bagnall, Ltd., are showing representative models from their range of materials handling trucks including many new additions. Among these is the type SFR fork truck which permits stacking and storing within 6ft aisles, and two new rider fork trucks with capacities of 2,400 and 3,000 lb respectively. All electrical components on the new Conveyancer type F.E.4 fork truck are contained in robust flameproof enclosures constructed in accordance with B.S. 229. Its capacity is 4,000 lb, at 20in load centre, and a 4,500 lb model will also be available. The company also demonstrates a new "Load-Clamp" fitted to a 4,000 lb capacity electric fork truck. This attachment introduces a new technique of unit load handling without pallets and has been designed for the handling of cartons, boxes, cases or crates.

Very many manufacturing industries carry out electroplating work to some extent and one of the foremost manufacturers of this type of equipment, W. Canning & Co., Ltd., have on display a wide selection of electrical equipment such as plating generators, resistances, meters, polishing equipment, compositions, brushes, wheels, etc. A device which is rapidly gaining popularity with the Electricity Boards is the "Tirfor" pulling and lifting machine shown by Tirfor, Ltd., a highly portable device operating on the block and tackle principle. Each machine is supplied with 60ft of flexible steel wire rope with a hook fitted on one end, wound into a portable rope reeler. Among its many applications it can be used for pole erecting, line tensioning, pulling through cables, handling cable drums, moving transformers, installing overhead line transformers, switchgear erection, etc.

Components machined from nylon rod, slightly modified in design, are often produced at a lower cost than existing components made from conventional material. On view on the Plastic Engineers, Ltd., stand are many examples of "Extrudlon," extruded nylon rod widely used in the electrical industry because of its non-inflammability, heat resistance and toughness. Among examples shown are relay switches, coil formers, terminal blocks, gears and bearings, and electric shaver and food mixer parts.

The number of companies showing domestic electrical equipment is small. L. G. Hawkins & Co., Ltd., display a complete range of domestic electrical appliances including fires, convectors, kettles, toasters, irons, etc., and, in particular, their latest hair dryer, the "Fair Lady," complete with hood attachment in presentation box. The Kenwood Manufacturing Co., Ltd., demonstrate their many food mixers including a new minor de-luxe model and also the "Activair" fan heater. Lighting fittings and accessories enjoy a good representation, and several new contemporary style fittings are to be seen on the Osborn Manufacturing Co.'s stand.

To-day (Friday) is the last day of the Fair.

Letters to the Editor

Letters should bear the writers' names and addresses, not necessarily for publication. Responsibility cannot be accepted for the opinions expressed by correspondents.

Fault Classification and Analysis

I SHOULD like to comment upon the lucid article by Messrs. Jesty and Stewart: "Fault Classification and Analysis," which appeared in the *Electrical Review* of 26th April. My interest lies in the scope for variant placings of faults within the tables of subdivisions. In Table 1 (i), for example, the causes of faults and the types of equipment are listed in one sequence, with the result that it is possible to classify a fault in either of two places; e.g. breakdown of insulators through weather conditions can be classified in Class B (weather) or in Class H (insulators).

A minor modification to the scheme, as follows, would obviate this difficulty. Separate causes of faults from items of equipment and give one of them a different notation; something on the following lines could be produced: a-z, voltage range; i-vi, main divisions (overhead, underground cables, etc.); A-Z, agency, or cause of fault (birds, weather, etc.); 1-10, item of equipment.

I have no doubt that the scheme is working well in its present form, but I suggest that the above modification would reduce what is a very real risk of confusion.

Hebburn-on-Tyne. J. T. GRAHAM.

Corrosion in Earthing Systems

IN your issue of 12th April, Mr. R. A. Lowe, commenting on the paper by Mr. Humphries on "Large Earthing Systems," drew attention to the danger of corrosion being accelerated by the cell formed between copper and other metals.

My contribution to the discussion of this paper dealt with this subject and I can assure Mr. Lowe that it is receiving attention. Potential surveys are being made in substations with various kinds of earth electrode. The adverse effects due to the electrodes can be assessed by measuring the resulting positive change in the potential of metal with respect to the soil.

Although in a few cases corrosion has been accelerated and a small number of corrosion faults have occurred, in the majority of cases the effect due to copper earthing electrodes has been negligible. Thus, at least until wider experience has been gained, there seems to be no justification for a general change of practice. However, surveys are continuing in existing stations and those in the course of construction.

J. H. GOSDEN,
Senior Assistant Engineer,
Research Section,
Central Electricity Authority.

London, S.E.1.

Proposed Somerset Nuclear Station

THE inquiry into the Central Electricity Authority's application for consent to the erection of a nuclear power station at Hinkley Point, Somerset, was held this week by Mr. H. W. Grimmit (Ministry of Power) and Mr. H. R. Wardrill (Ministry of Housing and Local Government).

The Somerset County Council, Taunton Corporation, Bridgwater Rural Council, the National Farmers' Union, the Quantock Seaboard Defence Committee, the Friends of Quantock, the Somerset River Board, the Council for the Preservation of Rural England and the Somerset Federation of Women's Institutes were among the bodies represented at the inquiry. Mr. S. B. R. Cooke, on behalf of the C.E.A., said it was expected that the capacity of the Hinkley Point station would be about 500 MW and on that basis the amount of cooling water would be 35 million gallons an hour. The tender for the station had not yet been received.

VIEWS on the NEWS

By REFLECTOR

CORRESPONDENTS to the Hull *Daily Mail* have protested that because the Yorkshire Electricity Board does not offer consumers appliances on simple hire they are being done out of their rights. In replying to them Mr. C. Cameron Kirby, the Hull Sub-Area manager, rightly says that there was never any legal compulsion upon electricity supply authorities to institute schemes of simple hire. The Yorkshire Board had, however, introduced hire-puchase schemes which, in terms of the amount of instalments, compared very favourably with what would have been an economic rental for hired appliances. But the Government's restrictions on hire-purchase had necessitated the alteration of the terms to something more onerous. I used to think years ago that the electricity supply authorities should offer simple hire schemes but conditions have altered so much that the necessity for them has become much smaller. If people are now able to buy expensive television sets on hire-purchase there seems to be little reason why more essential appliances should not be acquired in the same way. Again, the present-day cost of labour and materials for maintenance would necessitate fairly high rentals, which the consumers wouldn't like.

* * *

The chairman of the Wellington (Somerset) U.D.C. has described electric substations as "eyesores." They can be, of course, if they are not well designed and placed, which may possibly be true of the particular substation to which the chairman referred, although it must be said that he was speaking before the actual erection of the building. I have come across numerous attempts, mostly successful, to fit substations into their surroundings. For instance, in London there is one in a small park built on the lines of a summer-house and I have seen one in the Lake District which looks like (and I believe originally was) a rather pretty cottage. With present-day restrictions on expenditure the Electricity Boards are practically forced to provide substations of a "utility" character although they generally do their best to place them out of sight.

* * *

Much is being made of the "Three Wise Men" of Euratom—Messrs. Louis Armand, Franz Etzel and Francesco Giordani. While I do not question their wisdom I feel bound to say that we have three, or more, men in this country who may be considered even wiser in nuclear power matters. No doubt the United States could make the same claim, for much of the "Wise Men's" recent report is based on work done in our two countries.

* * *

A 15-year-old boy engaged in the firewood business was fined the other day at Halifax for the fraudulent diversion of electricity. It appears that he bored through the brick wall of a farmer's supply point and ran leads to a motor driving a circular saw. The leads were said to have been of "unsuitable television wire" (as though there were a suitable type) and there were no earthing arrangements. In extenuation of his offence the lad pleaded that he could not obtain petrol for the engine which ordinarily drove his saw and so he made this conversion—and diversion.

* * *

Reported in the *Empire News* is the case of a woman at Boston, Lincs, who was burned in the course of a fair-ground act involving the use of an "electric chair." The nature of the performance is not stated but the woman and her husband decided to continue it, with a variation for safety purposes. Asked what went wrong, the husband said:—

> "It is the first time we have worked off a diesel generator and I think that may have had something to do with it."

Probably some oil got into the connections.

* * *

Preliminary work in connection with the Kariba Gorge (Rhodesia) hydro-electric scheme is going ahead rapidly despite difficulties in securing and training labour. In an article on the work appearing in the "Bulletin" published by Richard Costain, Ltd., and associated companies, there is the following interesting sidelight on the labour situation:—

> "In addition to teaching these unskilled African labourers how to work it was necessary to make them fit for work. Much is said and written about the exploitation of the black man by the white. . . . The Africans who came to us straight from their natural habitat were so starved of protein that they have averaged a two-stone increase apiece during the first three months that they were 'exploited' by this particular company."

* * *

No doubt many of my older readers will recollect the Brennan gyroscopic monorail system of half a century ago. Reporting on the invention, which failed to catch on, the *Electrical Review* of 17th May, 1907, said:—

> "A great sensation has been created in the lay Press, and a modified echo of it appears to have found its way into the technical Press, as the result of Mr. Louis Brennan's invention of a 'gyroscopic train.' As a 'scientific toy,' to quote Sir William Preece's historic phrase in another connection, the Brennan monorail car is highly interesting; but that is probably the extent of its usefulness. Be it remembered that if from any cause whatever the gyroscopes stop, the car, which, we are told, may be travelling at 100 miles an hour, will come literally under the sway of gravitation; the inventor provides against this eventuality by means of what appear to be a pair of stilts, which automatically protrude themselves from the sides of the car. Should these stilts fortunately escape collision with chance obstructions, and meet the ground at the precise instant when the car comes to rest on a level, all may be well, and we shall regard with admiration, not unmixed with amusement, the spectacle of a railway car precariously straddling on a tight-rope with the aid of a pair of props."

PARLIAMENTARY REPORT

Finance Bill Debate

Explaining the Finance Bill in the House of Commons last week, Mr. Enoch Powell, Financial Secretary of the Treasury, said that in addition to implementing the Budget proposals the Bill made various minor financial adjustments. In 1954, he said, a block of capital was transferred from the British Electricity Authority to the South of Scotland Electricity Board in the form of a loan. Clause 37 of the Bill made the consequential adjustment enabling the C.E.A. to transfer to the Board, along with the loan itself, the disallowance of part of the interest paid on it for profits tax purposes.

In the debate on the Bill, Mr. Victor Yates complained that the Government had done nothing to get rid of purchase tax which was wrong in principle and pernicious in its application.

Mr. Wade, commenting on the surtax reliefs, said that if it was the aim of the Chancellor of the Exchequer to provide additional incentives to those whose efforts were of particular importance to the expansion of the economy, the technicians and young administrators and the kind of people who were now emigrating should have received a concession. In the main they came in the £1,000-£2,500 category.

Mr. Leather said the idea that only a handful of company directors were affected by the surtax reliefs was wrong. Much money was spent on educating young technicians and technologists and it was no use telling them that if they worked their way to the top the rewards would be taken away in surtax.

Mrs. Jean Mann thought there was a good case for reducing purchase tax on cathode ray tubes.

Mr. Raymond Gower complained that professional people were able to obtain tax allowances for books and professional journals which kept them up-to-date with modern developments, but employed people, because they were assessed under a different schedule heading, did not have the same benefit. He asked the Government to correct this anomaly.

Tax on Labour-Saving Appliances

Mr. Nabarro pointed out that the cutting of the purchase tax on certain domestic goods had created a state of affairs in which the vacuum cleaner carried tax of 60 per cent whereas a dustpan and brush or a hand carpet sweeper carried only 15 per cent tax. The same comparison could be made between an electric washing machine and hand-operated mangle. The effect of the Bill was that modern electrical appliances which all M.P.s wanted housewives to have in their homes often carried four times the rate of tax carried by the old-fashioned equivalent appliances.

Mr. Bence: "But we want to export them."

Mr. Nabarro said that was not the answer. The leading electrical manufacturing firms could furnish, without undue strain on the metal-supplying industries, greatly increased quantities both for the home and export markets. They were anxious to do so. Their export prices were being affected to-day very largely by this artificial drag upon sales in the home market created by an inordinately high rate of purchase tax on the development of appliances for domestic use. This penal taxation on gas and electrical goods was merely putting a premium on drudgery in the home. Before the next Budget the Chancellor should have an inquiry into all the iniquities of purchase tax with a view to scrapping it in 1958 and replacing it with a simply-operated turnover tax at a modest rate on the total consumption of the nation.

Replying to the debate, Mr. Peter Thorneycroft, Chancellor of the Exchequer, made it clear that during the committee stage he would not be able to extend taxation reliefs beyond the £100 million which he had set as the limit. He believed that production would take an upward turn, but we could not really afford it unless we could match it with more exports to pay for the imports coming in, and with more productivity. We could then afford more goods produced for home consumption and for investment.

The Bill was read a second time.

Technical Training

Mr. Parkin was informed by Sir Edward Boyle, Parliamentary Secretary to the Ministry of Education, that the Government's plans for increasing the output of scientific manpower depended on the expansion of university facilities and of all types of courses in technical colleges. He could not say precisely to what extent they would require to increase the contribution made by sandwich courses in particular, but it might be by as much as five or six times the present number. The technical colleges were already making encouraging progress in developing new courses in consultation with industry, and the necessary accommodation was being and would be provided as part of the programme for the development of technical education.

Grants for Farm Supplies

During the committee stage of the Agriculture Bill, which makes provision for grants of one-third of the cost of supplying electricity to farms, Mr. Sidney Dye asked the Minister of Agriculture to consider giving a larger grant. Generally speaking, the farms still awaiting a supply were those which it would be most difficult and most costly to serve. There was a case for asking that when a farm would greatly benefit from the supply of electricity, and when it was not likely to get it because of the distance that the supply had to be brought, there should be a grant of 50 per cent. All M.P.s representing rural constituencies were getting more correspondence on this question; it affected productivity and the ability of farmers to get men and their families to work on the farms.

Cables or Overhead Lines

Mr. Nabarro asked the Paymaster General what were the comparative costs of laying main transmission and main distribution lines for electricity underground as compared with the costs of placing them overhead.

Mr. Maudling said that, generally speaking, underground lines cost from four to eight times as much as overhead lines but the difference would be much greater in the case of the supergrid. He later circulated this information:—

COMPARATIVE COSTS OF PLACING OVERHEAD LINES AND LAYING UNDERGROUND CABLES

Type of Main	Overhead cost per mile*	Underground cable cost per mile
	£	£
275 kV standard supergrid	25,000	300,000–400,000
132 kV standard grid line	10,000	50,000–80,000
33 kV	2,000–3,000	10,000–15,000
11 kV	800–1,900	3,000–9,000

* Costs vary according to the sizes of conductors and types of construction used. Underground cable laying costs are particularly affected by different local conditions. In the case of the supergrid, where the cost shown is an estimate, the laying of underground cable would present serious technical problems. Substation costs are not included.

Conversion of Power Stations from Coal to Nuclear Energy

Mr. Albert Roberts asked the Paymaster General, in view of his declared intention to build only nuclear generating plants after 1970, what consideration he had given to the technical possibilities of converting coal-fired plant to nuclear energy as the coal-fired plant became obsolete.

Mr. Maudling replied that such conversion was not at present a practical proposition, but it was a possibility that would be kept carefully under review. No decision had yet been taken to cease building conventional stations after 1970 or any other date.

Asked if the Minister would set up a committee to inquire whether it was technically possible to do this conversion, Mr. Maudling said he did not

think there was any need to because the Atomic Energy Authority had this matter very much under consideration. The problem at the moment was that the temperature and pressure of the steam in conventional and nuclear stations were very different. With further technical development on the nuclear side conversion might be possible.

Tenders for Nuclear Stations

Mr. Palmer asked the Paymaster General if foreign engineering firms would undertake work in connection with the expanded nuclear power construction programmes now announced.

Mr. Maudling said they could confidently expect, in view of the leading position of British industry, that the nuclear plant required at least for the early stages of the programme would come entirely from British sources. The placing of orders was, however, within the discretion of the electricity authorities and he had no doubt that they would invite foreign firms to tender for other parts of the programme if they thought it advisable to do so.

In reply to a further question, Mr. Maudling said that as far as the Ministry was concerned the actual placing of contracts for nuclear stations was done by the electricity authorities, who had said they intended to do so on the basis of the widest possible competition.

Mr. Chetwynd asked if there was evidence that the electricity authorities were specifying that only certain firms might be used in carrying out this work.

Mr. Maudling: "No. The information I have from the authorities is rather to the contrary."

Kariba Resettlement

The Secretary for the Colonies, Mr. Lennox-Boyd, informed Mr. J. Johnson that about 450 Africans, in four villages, had so far been moved from the Zambesi valley bottom following the flooding of their lands under the Kariba Dam scheme. It was expected that 16,000 would be moved in 1957-58.

Asked by Mr. Johnson if he would give the matter his personal attention because there was much anxiety in Rhodesia, Mr. Lennox-Boyd said he was acutely conscious of the human implications of the problem, which he had examined with care when he was in Rhodesia, and pledged himself to do what Mr. Johnson asked.

Nationalised Industries' Finances

Mr. Grimond asked the Chancellor of the Exchequer what was his intention as to reducing the overdraft of the nationalised industries and as to their capital financing.

Mr. Peter Thorneycroft said the total of the overdrafts of the nationalised industries had been reduced from £123 million on 15th August, 1956, just before the first Exchequer advances, down to a figure of £55 million on 17th April last, representing their current short-term need. He could not yet make a statement about the Government's intention as to the financing of the industries after the expiry of the Exchequer's lending power in March, 1958.

Mr. Grimond asked whether the financing, either long-term or short-term, would be done by overdraft until a decision was taken.

Mr. Thorneycroft said the contrary was rather the case. It was being done long-term largely by overdraft, and under this new method the overdraft was limited to short-term needs as in the case of ordinary industry.

Superannuation Proposals

Dame Irene Ward asked the Paymaster General when he proposed to accept the Central Electricity Authority's proposals for giving to protected persons the benefits of the Local Government Superannuation Act of 1953.

Mr. Maudling said these proposals were still under consideration.

Labour Rates in Mauritius

In reply to Mr. John Rankin, Mr. Profumo, Under Secretary of State for the Colonies, said the Central Electricity Board of Mauritius put out to contract certain works such as the erection of poles for overhead lines. Contracts were based on tenders per unit of work and were not directly related to wages. Details of wages paid by contractors were not available, but the normal wage for contractors' labourers was about 5s or 6s a day.

Prices of Materials

In the accompanying table we give the basis prices of the more important materials used in the electrical industry. The figures given are the selling prices and are those quoted on Tuesday last.

ALUMINIUM ingots	ton £197 0s 0d
COPPER, H.C. Electro	ton £238 5s 0d
Fire Refined 99·70%	ton £237 0s 0d
Fire Refined 99·50%	ton £236 0s 0d
COPPER Tubes ..	lb 2s 3½d
Sheet	ton —
H.C. wire and strip ..	ton £288 5s 0d
LEAD, English ..	ton £97 5s 0d
Foreign	ton £96 0s 0d
MERCURY	flask £88 0s 0d
TIN, block (English) ..	ton £762 0s 0d
ZINC, G.O.B. Foreign	ton £82 15s 0d
Electrolytic	ton —
BRASS Tubes (solid drawn)	lb 1s 10⅞d
Sheet	ton —
Wire	lb 2s 7½d
PHOSPHOR BRONZE Wire	lb 4s 0d
PLATINUM	oz £34 0s 0d
RUBBER, No. 1 R.S.S. spot	lb 27⅛d—27½d

E.D.A. Public Speaking Competition

The Faraday Silver Challenge Shields, the major awards in the E.D.A. Public Speaking Competition, held in London on 8th and 9th May were won by the Merseyside and North Wales Board (women's section) and the North Western Board (men's section). Miss Joan M. Williams, a demonstrator in the Conway Valley District of M.A.N.W.E.B., won the women's contest with an address on "So You Want to be a Demonstrator." Mrs. Irene Bird, service centre assistant (Doncaster, Y.E.B.) and Miss Pamela W. Leith, demonstrator (Worcester, M.E.B.) were second and third respectively. Mr. Dennis I. Wrigley, architectural assistant, North Western Board, headquarters, won the men's contest with an address on "Colour and Design." The runner-up was Mr. D. W. Lithgow, showroom assistant (Twickenham, S.E.B.) and Mr. Peter Watkins (operational research station, M.E.B. headquarters) was third.

The judges for the women's contest were Miss Vera Norvick (E.A.W.), Mr. Frank Phillips (B.B.C.), Mr. Harold Purcell (Film Producers' Guild) and Mr. Alan East (former chief engineering inspector, Ministry of Fuel and Power). Adjudicating at the men's competition were Miss Mary George (E.A.W.), Mr. Lionel Marson (B.B.C.), Mr. Frank Hoare (Merton Park Studios) and Mr. E. A. Mills (late deputy chairman, L.E.B.). Mr. J. I. Bernard (director and secretary, E.D.A.) was the chairman at both sessions, and Mr. V. W. Dale (vice-president, E.D.A.) presented the awards.

Mr. Dennis I. Wrigley and Miss Joan M. Williams, winners of the E.D.A. Public Speaking Competition, with their shields

PERSONAL AND SOCIAL

News of Men and Women of the Industry

Sir Josiah Eccles, C.B.E., M.M., deputy chairman (operation) of the Central Electricity Authority, has been appointed a member of the Clean Air Council established under the Clean Air Act, 1956.

Lt.-Colonel J. Rankin, O.B.E., deputy chairman of the Merseyside and North Wales Electricity Board, has been elected a member of the Council of the Industrial Association of Wales and Monmouthshire.

Mr. R. F. Richardson, M.B.E., M.I.E.E., at present assistant chief commercial officer of the Central Electricity Authority, has been appointed chief commercial officer of the South Western Electricity Board and takes up his new duties on 15th June. Mr. Richardson received his early training with Callender's Cable & Construction Co., Ltd., and entered the electricity supply industry in 1936 as a sales engineer with the Westminster Electric Supply Corporation, where he was responsible for much development work and pioneered several large scale cooking and heating installations in West End buildings. During the war he served for a period as an electrical and mechanical officer and subsequently commanded a Field Park Company, Royal Engineers, throughout the N.W. European campaign, being awarded the M.B.E. Afterwards he was in charge of the St. James and Mayfair Districts of Central London Electricity until 1948 when, following a temporary period as district commercial officer at Ilford, he was appointed a section head in the Commercial Department of the London Electricity Board (North Eastern Sub-Area). He joined the commercial manager's staff at the B.E.A. in 1952 and was appointed an assistant commercial manager in the following year.

Mr. R. F. Richardson

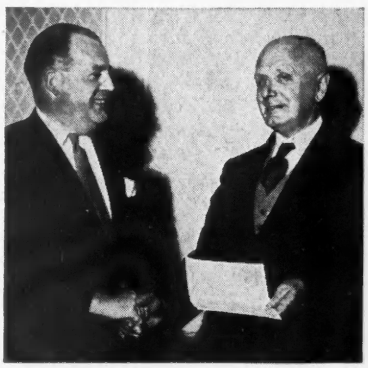
Mr. Richardson has become widely known as a result of his work with the British Electrical Development Association and various committees concerned with technical and promotional activities. He is the chairman of the Appliance and Method Development Sub-Committee which was recently set up by the Utilisation Research Committee of the Central Authority and Area Boards. He is the United Kingdom member of the Organisation for European Economic Co-operation group of experts on electricity rates and is also associated with the work of the International Union of Producers and Distributors of Electrical Energy.

Mr. J. A. Crispin, B.Sc.Tech.(Hons.), A.M.I.E.E., senior assistant engineer, Generation and System Operation Branch, Central Electricity Authority headquarters, has been appointed system operation engineer, South Eastern Division. After receiving his technical education at Manchester University, during which time he was a student apprentice with Ferguson Pailin, Ltd., Mr. Crispin joined the Central Electricity Board in 1935 as junior engineer in the North West England District. He subsequently served as assistant control engineer, assistant engineer and senior control engineer in the Board's South East England District until 1947 when he was appointed assistant engineer in the Operation Department at headquarters. The following year, with the reorganisation of the electricity supply industry, he took up his present post with the Authority.

Dr. W. A. C. Coode-Adams, who has been principal of Faraday House Engineering College since 1937, has been appointed advisory principal as from the beginning of this term. **Mr. G. H. R. Martin,** A.M.I.E.E., has been appointed acting principal.

To mark the retirement of **Sir Herbert Barber,** after 44 years as manager of the Manchester branch of Johnson & Phillips, Ltd., a branch managers' dinner at which he was the principal guest was given by the company on 30th April, at the Majestic Hotel, Harrogate. During the function Sir Herbert was presented with a cheque by Mr. J. B. McRostie, sales director, and with a travelling clock by Bailie Bruce Russell on behalf of his fellow branch managers. Mr. McRostie spoke of Sir Herbert's prominence in political and public life, including two terms of office as Mayor of Southport.

Mr. J. B. McRostie, sales director of Johnson & Phillips, Ltd., presenting Sir Herbert Barber with a cheque on his retirement after 44 years as manager of J. & P. at Manchester



Sir Herbert Barber is succeeded as branch manager at Manchester by **Mr. A. F. Herbert,** previously manager of the J. & P. Bristol branch, who joined the company in 1946 after service in the R.A.F. during the war. He became manager at Bristol in 1949 and has been concerned with many J. & P. electrification schemes at Bristol and in the West Country. His place at Bristol is taken by **Mr. F. Williams,** who joined the Birmingham branch as senior sales engineer in 1945 after serving as assistant electrical engineer with Fisher & Ludlow, Ltd.

Mr. A. F. Herbert

Mr. W. C. Hine, Associate I.E.E., superintendent at Little Barford generating station, retires from the service of the Eastern Division, C.E.A., on 30th June after having completed 40 years' service in the industry, the last nine of which have been spent as station superintendent at Little Barford. **Mr. E. G. Spilling,** A.M.I.E.E., deputy superintendent at Westwood generating station, has been appointed to succeed Mr. Hine at Little Barford.

Mr. E. G. Spilling

Mr. K. J. Rowland has been appointed as manager of the Cardiff office of Drake & Gorham (Contractors), Ltd., and will commence his duties in that capacity as from 3rd June next. Mr. Rowland will be succeeding **Mr. D. B. Williams,** who acted as engineer-in-charge at Cardiff and, as we have already reported, has joined the National Inspection Council for Electrical Installation Contracting.

We are informed that subsequent to the annual general meeting of the British Electrical Development Association last week **Mr. Victor Dale,** the retiring director and secretary, was

Mr. D. Bellamy presents the cheque to Mr. Victor Dale

appointed a vice-president of the Association. It is gratifying that in this way Mr. Dale's connection with E.D.A., dating from its origin, is to be continued.

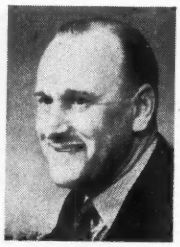
We reproduce a photograph taken before the annual meeting showing Mr. D. Bellamy, the retiring chairman of the E.D.A. Council, presenting Mr. Dale with a cheque subscribed to by his many friends in the electrical industry.

Mr. J. G. Robertson, for many years with the English Electric Co., Ltd., latterly on their Scottish electronic sales of computers and r.f. heating, has joined Elesco Electronics, Ltd., as technical sales manager in succession to **Mr. W. O. Buchanan** who has taken up an appointment at Stowe College.

Philips Electrical, Ltd., has appointed **Mr. J. T. Moore,** formerly product manager for radio and television, as marketing manager of the Television and Radio Division. In his new post Mr. Moore will co-ordinate the whole of the division's marketing activities which cover a wide range of electro-acoustical products in addition to radio and television. He will be directly responsible to Mr. A. L. Sutherland, director in charge of the main Television, Radio and Musical Equipment Group. Mr. Moore has been with Philips since 1928.

Mr. S. Poole, formerly regional manager (lighting and electrical appliances) for the Southern Region of Philips Electrical, Ltd., has been appointed regional manager of the newly formed South West Region of the company. He will be based at Bristol and will be responsible for activities in those areas at present covered by the Cardiff and Bristol branches. Mr. J. Jordan and Mr. D. E. Beard will continue as branch managers in their respective areas. Mr. Jordan will be additionally responsible for all radio and television matters throughout the new region.

Mr. J. T. Moore



Mr. S. Poole

Mr. Poole has been with the company for thirty-one years.

The Council of Industrial Design has appointed two new industrial officers, **Mr. H. Upjohn** and **Mr. P. Whitworth.** In future they will share responsibility for the engineering industries with Mr. T. Gregson, an industrial officer at the Council since 1954. The appointments have been made because **Mr. G. Williams,** a senior industrial officer since 1949, left the Council at the end of April to become design officer of the British Transport Commission.

Mr. Upjohn has been a designer for the Atlas Division of Thorn Electrical Industries, Ltd., for the past three years and Mr. Whitworth has been working in practice on housing, industrial and commercial projects.

At the annual general meeting of the Association of British Ebonite Manufacturers, held on 2nd May, **Mr. A. W. Hopkins,** of the General Electric Co., Ltd., was re-elected chairman for 1957-58.

Mr. G. P. Cundall, B.Sc., author of the article on "Power Factor Improvement" (page 918), studied at Leeds University and received his training with British Insulated Callender's Cables, Ltd., with whom he subsequently served as a site engineer in London and then sales engineer. In 1955 he joined R. W. Gregory & Partners as an assistant engineer, chiefly concerned with electrical installations, and at the same time he became a part-time lecturer in electrical engineering at Rutherford College of Technology. From 1950 to 1951 he was chairman of the I.E.E. North-Eastern Students' Section and his chairman's address, entitled "The Development of Power Cables," was awarded a Students' Premium.

Mr. G. P. Cundall

Mrs. M. Walkins has been appointed Press relations officer to Rubery, Owen & Co., Ltd., Darlaston, in succession to Mrs. C. Clymer. Mrs. Walkins was previously publicity officer of Auto Diesels, Ltd., of Uxbridge, Middx.

At Lancaster House on 7th May Lord Mills, Minister of Power, presented awards, on behalf of the Queen, to thirty-eight members of the coal, electricity, gas, oil and steel industries. These included the B.E.M. and the Queen's Commendation for Brave Conduct. Among the recipients were **Desmond Allan Ross** and **Harold Edmund Yates,** who received the B.E.M. for gallantry during an incident at Kirkstall power station, Leeds.

Lord Mills (left) talking to Mr. D. A. Ross and Mr. H. E. Yates after presenting them with the B.E.M.

They helped in rescue work when scaffolding collapsed inside a 350ft chimney.

Mr. H. W. Heyman, B.Sc., M.I.E.E., managing director of Smith's Delivery Vehicles, Ltd., has, for the eighth time, been elected a member of the Council of the Society of Motor Manufacturers and Traders, Ltd., to represent the battery electric road vehicle interests.

Mr. H. Dennis V. Ellis has been appointed to the board of the City Electrical Co. (C.E.C., Ltd.).

Mr. A. F. Plummer, the president, was in the chair at last Tuesday's luncheon of the **Electrical Industries Club** when the speaker was Mr. Peter Galsworthy, of Associated Rediffusion. Mr. Galsworthy explained very lucidly the organisation of independent television and gave some indication of the promoters' views on programme matters and advertising. The vote of thanks to the speaker was proposed by Mr. R. Baldwin.

Mr. S. Hardman, B.Sc.Tech., has been appointed assistant superintendent, Switchgear Department, of the Metropolitan-Vickers Electrical Co., Ltd. He joined Metropolitan-Vickers as an apprentice in 1938, continuing in the company's manufacturing departments, originally as tool engineer and later as development engineer, until 1950. His technical education during this period was at the Royal Technical College, Salford, various distinctions leading to a

Mr. S. Hardman

Technical State Scholarship. After taking an honours degree in mechanical engineering at Manchester University, Mr. Hardman returned to the M-V Works in 1953 as manufacturing engineer in the Switchgear Department.

The second meeting of the Scottish and Northern Centres of the **Illuminating Engineering Society** was held at the Peebles Hotel Hydro on 3rd and 4th May. Dr. W. E. Harper, the president, opened the initial meeting in the Peebles Town Chambers Hall. Mr. P. S. J. Underwood, chairman of the Newcastle Centre, introduced the first lecturer, Mr. D. W. Durrant, who presented a paper on "Decorative Lighting—The Designer's Approach." The discussion was opened by Mr. E. C. Lennox and Mr. G. E. L. Comrie.

In the evening an official reception was held in the ballroom of the Hydro Hotel when the guests were received by the president and Mrs. Harper. After dinner there was dancing and a demonstration by the Royal Scottish Country Dance Society.

On Saturday morning a further meeting was held in the Chambers Hall when Mr. E. T. Radford, chairman of the Glasgow Centre, introduced Mr. L. C. Kalff, of Eindhoven, Holland, who presented a paper on "The Best Seeing Conditions during Work." The discussion was opened by Dr. R. G. Hopkinson, followed by Mr. J. S. McCulloch.

Mr. N. Elce, M.Sc.Tech., M.I.Mech.E., F.R.S.A., director and chief mechanical engineer of the Metropolitan-Vickers Electrical Co., Ltd., has been elected a vice-president of the Institution of Mechanical Engineers. As we have already reported, the new president is **Sir George Nelson,** Bt., chairman of the English Electric Co., Ltd.

Mr. N. Elce

Mr. Elce joined the Institution as a graduate in 1919, became an associate member in 1925, and a member in 1939. He served on the branch committee of the North Western Branch, becoming chairman of the Branch in 1952; he was elected a member of Council in 1954.

Mr. C. Leighton, who has retired from the position of superintendent of the Birchills and Walsall New generating stations, has been presented with a cheque subscribed to by the 400 employees at these stations.

Executives and members of the staff of the G.E.C. from all over the world presented **Mr. Leslie Gamage,** vice-chairman and joint managing director, with a specially-designed heavy silver casket to commemorate his 70th birthday on 5th May. The casket, which is lined with gold, contains four goblets and a flask, also of silver lined with gold. The lid of the casket has special significance for Mr. Gamage. It carries embellishments representing his achievements and interests. At the four corners are worked the emblems of his school (Marlborough), his college (Exeter, Oxford), his regiment (The Queen's), and the Worshipful Company of Glaziers of which he is a past Master. The lid is surmounted by a globe of amethyst and a falcon of gold representing his world travels in the course of his business life.

The casket presented to Mr. Leslie Gamage on his 70th birthday

The eleventh annual reunion of the **B.T.H. (Willesden) Long Service Association** took place at Wembley Town Hall on Friday last. The Association, originally formed in 1931, now has a membership of 315 and this year 12 members (employees who have served the company for 25 years) were added. Another 24 members qualified for certificates marking 30 years' service. The principal guest was Mr. E. H. Ball, managing director, who was introduced by Mr. C. F. Humphreys, manager, Switchgear Engineering Department, and chairman of the Association. During the evening there was dancing and an excellent cabaret.

At the Royal Hotel, Cardiff, on 10th May **South Wales Switchgear, Ltd.,** held their second annual apprentices' dinner. Some 200 apprentices and guests attended and were afterwards entertained with an enjoyable series of vocal and instrumental items by some of the apprentices. Awards were presented to the outstanding apprentices in each section by Mr. A. J. Nicholas, the managing director.

Mr. E. A. Taylor, executive sales director of Belling & Lee, Ltd., was recently presented with a silver tea service to commemorate the 25th anniversary of his service with the company. The presentation was made by Mr. E. M. Lee.

Mr. E. A. Taylor (right) receiving a presentation from Mr. E. M. Lee

Mr. C. G. Ramsay has retired from the position of chief superintendent engineer, Canadian Pacific Steamships, Ltd., Liverpool, after forty-five years' service with the company. He is succeeded by **Mr. E. O. Wilkinson,** assistant chief superintendent engineer.

Mr. F. Warhurst, M.B.E., M.I.E.E., has been appointed commercial director of the Brush Electrical Engineering Co., Ltd. Mr. Warhurst, who has now taken up his duties at the Loughborough factory, has been with the General Electric Co., Ltd., Telephone Works, Coventry, since 1930, having held a number of senior appointments. He has been commercial manager since 1949. From 1939 to 1945 he served with the Royal Corps of Signals, attaining the rank of lieut.-colonel.

Mr. F. Warhurst

The first meeting of the **A.S.E.E. Golfing Society** was held on 25th April at the Kingswood Golf Club when a Stableford competition was played for a trophy presented by the General Electric Co., Ltd. Over forty members and visitors took part. The winner of the trophy was the hon. treasurer, Mr. E. A. Langsdon, the runner-up being Mr. C. G. F. Aldridge. Other results were: Best 15 and under handicap, Mr. J. H. Mitchell; wooden spoon, Mr. A. Kelly; best score by visitor, Mr. J. Pugh; special prize for the most "o's" on his card, Mr. J. Gillespie. Lunch preceded the golf, and at the supper which followed the president, Mr. W. F. Parker, took the chair, and Mr. E. A. Fowler (G.E.C.) presented the trophy and golf balls to all the other prize winners. The main prize at the next meeting, at the Richmond Golf Club, Sudbrooke Park, Richmond, will be a trophy presented by Brush Electrical Engineering Co.,

Ltd. Application for membership should be made to the hon. secretary, Mr. C. J. Penny, c/o Brush Electrical Engineering Co., Ltd., Duke's Court, Duke Street, St. James's, S.W.1.

OBITUARY

Mr. L. Howles.—We regret to report the death of Mr. Leonard Howles, C.B.E., M.I.E.E., M. I. Struct. E., chairman of the South Wales Electricity Board since its inception in 1948. Mr. Howles had attended conferences in London last week; he was taken ill on Saturday and died in Charing Cross Hospital on Monday.

The late Mr. L. Howles

Mr. Howles was born at Smethwick in 1896 and attended the local Technical College. He later joined the former Shropshire, Worcestershire & Staffordshire Electric Power Co., rising to the position of general manager. In 1935 he took up a similar post with the South Wales Power Co. and held it until the nationalisation of the supply industry. Mr. Howles had served on the Consultative Committee for South Wales and South West England of the Central Electricity Board and the Electricity Commissioners' committee on uniformity of tariffs, and he had served on the Councils of the former Incorporated Association of Electric Power Companies, the South Wales Institute of Engineers and the British Electrical Development Association and on the I.E.E. Western Centre Committee. He was appointed an Area Board member of the C.E.A. in 1956, having served for a previous term in 1950-51.

Mr. Howles is survived by a widow, a son and a daughter, to whom we extend our sympathy. Cremation took place yesterday (Thursday) at Golders Green, London, N.W.

Mr. Gerard Ernest Jewell, director of the London Electric Wire Co. & Smiths, Ltd., and the Liverpool Electric Cable Co., Ltd., died on 6th May at the age of fifty-nine. Mr. Jewell had been with the company for thirty-eight years and had represented it on many electrical association committees, of a number of which he was chairman. Mr. Jewell leaves a widow, one son and two daughters.

Mr. Andrew O'Brien Brandon, B.A., consultant engineer to the Prestcold refrigeration division of the Pressed Steel Co., Ltd., died suddenly at Oxford on 18th April at the age of forty-five. He joined the refrigeration division in 1934 and was appointed consultant engineer about two years ago. Mr. Brandon had served on the Executive Council of the Institute of Refrigeration and its Educational and Research Committees. He also served on committees of the British Standards Institution and was a member of the advisory committee on refrigeration of the City and Guilds of London Institute and an examiner in the science and technology of refrigeration.

Mr. E. J. Emery, M.Brit.I.R.E., M.I.R.E., a member of the main board of Electric & Musical Industries, Ltd., and managing director of E.M.I. Sales & Service, Ltd., died suddenly on 10th May. Mr. Emery, who was 57, was widely known throughout the radio industry. He joined the Marconi Co. in 1916 as wireless officer, and in 1922 transferred to the Marconiphone Co. on the inception of radio broadcasting. Since then he had held many responsible positions in the E.M.I. Group, and was appointed to the main board last year. Mr. Emery had been chairman of the City and Guilds Advisory Committee on Radio and Television since its formation before the war, and he was also chairman of the Radio Trades Examination Board.

Euratom Nuclear Programme

In last week's issue brief reference was made to the report of the committee appointed last November by six countries forming the European Coal and Steel Community in regard to the building of nuclear power stations under the Euratom project. The countries concerned are Belgium, France, Western Germany, Italy, Luxembourg and the Netherlands (British office, 23, Chesham Street, London, S.W.1). The committee, composed of Messrs. L. Armand and F. Etzel and Professor F. Giordani, recommend the installation in these countries by the end of 1967 of 15,000 MW of nuclear generating plant (having an annual output of 100,000 million kWh) instead of the 6,000 MW at present planned.

The 15,000 MW is stated to be 2½ times that proposed in Great Britain, but the population of the Community countries is three times and its electricity output 2·8 times as much. These countries now import nearly 25 per cent of their total energy requirements, compared with 12 per cent for Great Britain. Without nuclear power energy, imports of the Community (usually oil) are expected to rise from the present annual value of $2,000 million to $4,000 million in 1967 and possibly to $6,000 million by 1975.

Reactors will be bought or built under licence from the United Kingdom or the U.S.A. in the first place, since the only full-scale designs immediately available are the gas-cooled Calder Hall type and the pressurised-water/boiling-water type. Initial costs are said to be rather higher for British than U.S. stations, but fuel costs are considerably lower. Costs per kWh at $0·011 to $0·014 are similar over a 15-year amortisation period and will probably fall, compared with $0·011 to $0·012 for new conventional power stations, which will probably rise.

The low operating costs of the earliest designs of nuclear stations are likely to make them economical throughout most of their useful life. The outlay required for the 15,000 MW target is estimated at $6,000 million against $2,000 million for conventional stations.

Switchgear Company's 25th Year

Switchgear & Equipment, Ltd., of Banbury, celebrates its 25th anniversary this year. The company was formed in 1932 by Mr. A. G. H. Oxley (managing director), to manufacture outdoor air-break switchgear. The original works near Banbury Station soon became inadequate and in 1938 new and larger works were opened on the present site in Southam Road, Banbury. These works have been extended from time to time but the company's greatest problem has been to obtain suitable labour. Some time back the factory was leased at Blantyre, Lanarkshire, where some of the work is carried out, and the company is now erecting a further factory at Brackley, a few miles outside Banbury, where the labour situation is better. At the Banbury works there is an apprentice school with instruction shops and a theatre in which lectures are given and technical films shown.

The original business of air-break switchgear is still the main business of the company but distribution switchgear of all types up to 132 kV is now made, and many new designs have been introduced by Mr. Oxley and his son, Mr. D. A. J. Oxley (assistant managing director). The business is mainly with the Electricity Boards but a considerable export business is also done and the turnover of the company now exceeds £1,000,000 per annum.

Last Friday the company held its annual staff dinner-dance and the visitors included a number of Electricity Board representatives. This function was quite informal and Mr. A. G. H. Oxley, who presided, confined his remarks to welcoming the staff and guests. To mark the 25th anniversary of the company he presented gold watches to two members who have been with it for the whole of that time—Mr. J. MacReady (works manager) and Miss G. Macpherson (in charge of accounts).

NEW RESEARCH CENTRE

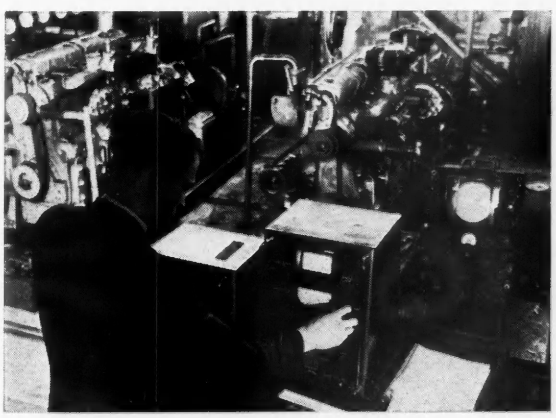
RUSTON & HORNSBY ESTABLISHMENT AT LINCOLN

THE preliminary to the construction of the present research centre at the Lincoln works of Ruston & Hornsby, Ltd., was a tour of similar large engineering plants in Germany, Switzerland and the United Kingdom by two of the company's senior engineers. They found that only at one diesel engineering plant in Cologne was there a separate research department comparable in size and purpose to that envisaged. The information gained from the survey confirmed the decision to house the physical requirements of every aspect of research, as far as possible under one roof. As a result, the specification included administrative and executive offices, laboratories and conference room in addition to the test areas.

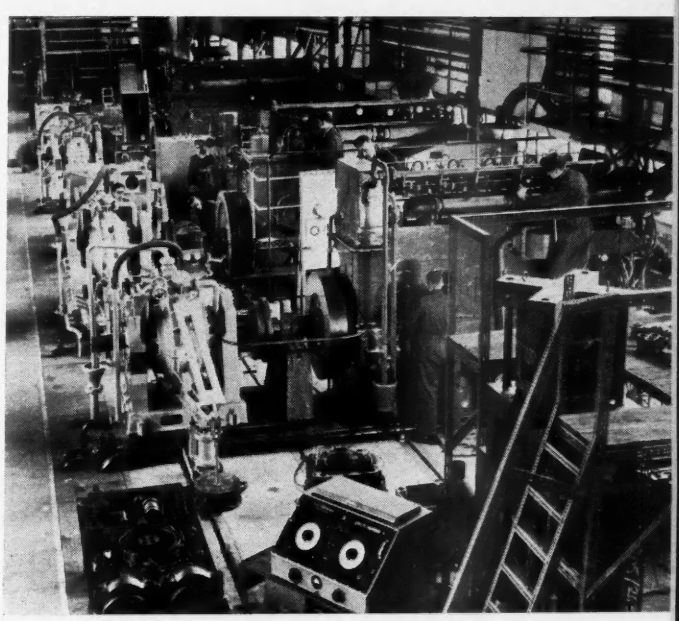
The new centre is equipped to carry out research and development work on the complete range of the company's diesel engines, gas turbines, locomotives, and a variety of activities connected with prototype projects. The actual capacity in terms of test bed operation is 40 high-speed engines, ten medium-speed engines and five (at present) gas turbines, with various rail track gauges outside the building to mount any size of diesel locomotive.

In the high-speed engine section the research and development work carried on includes the development of new air- and water-cooled engines; trial of accessories and components on current production engines prior to their approval for use on new engines; the development of normally aspirated engines to pressure-charged versions and of engines with higher ratings; tests with low-grade fuels and lubricating oils of all types before approval; investigations into service failures of unknown origin; operation of field research trials; and cold and hot room tests.

The work carried out in the medium-speed engine section is directly concerned with the improvement of engine performance—particularly with mechanical reliability and economy consistent with combustion and pressure charging. In this respect work is in progress to investigate the behaviour of alternative and new types of bearings desirable for higher engine ratings now under development. Much of the development work associated with the medium-speed engines is, for reasons of economy, carried out on production test beds since the tests are, in the majority of cases, of comparatively short duration. These consist largely of pressure charger matching, investigation into intercooled engine performance and performance on lower grade fuels, both to the specific requirements of customers.



A senior research engineer operating a Pametrada wave analyser during investigation into vibration in a six-cylinder diesel engine



Bay No. 1 containing medium-speed engines and test rigs

Facilities have been incorporated for every aspect of gas turbine development. Some of the major branches of this work are the thermodynamic and mechanical development of prototypes; the development of control systems; combustion of various fuels; prototype combustion chambers for new engines; the aerodynamic testing of turbine components; and investigation of proprietary articles such as fuel and lubricating oil pumps, control equipment, etc. One of the important features specifically related to turbine testing is the availability of at least four types of fuel at each test bed.

Development work on automatic control of a standard gas oil-fired TA machine, driving a 6·6 kV B.T.H. alternator is now drawing to a close. The engine is fitted with standard controls for gas oil running. The automatic control equipment is intended to give completely automatic starting and running up to predetermined governed turbine speed, initiated by push-button or mains failure detection relay; shut-down of turbine at any time, either by starting or running, by push-button or mains resumption relay; and automatic shut-down of turbine upon detection of lubricating oil failure, high lubricating oil temperature, high maximum gas temperature, starter motor contactor failure, flame failure, or control equipment supply failure during starting or normal running, After shut-down for any reason, the controls will revert to the conditions necessary for the next starting operation. Provision is made for manual starting of the turbine,

using the bare essential electrical circuits, should an emergency arise.

The TA prototype was first run in November, 1952. After being used for thermodynamic performance work and following the Olympia Exhibition of 1953, this engine was converted to run on coal tar fuel.

There are four laboratories on the ground floor of the office block. The metrology laboratory (not yet completely equipped) is intended for photo-elastic stress analysis work and to contain standards for temperature, pressure, surface finish, etc. An electronic laboratory is provided for the maintenance and construction of electronic equipment used for research and development work and an instrument-fitting laboratory for the maintenance and manufacture of equipment other than electronic, such as furnaces and a thermocouple welding machine. A stress and vibration laboratory—mainly related to strain gauge and vibration techniques—provides for the mechanical test of small engine and turbine components.

Research of all types dealing with products accommodated in the centre includes stress analysis investigations, fatigue testing of engine components, vibration investigations, investigations into noise problems and thermodynamic investigations, both practical and theoretical, into engine cycles, etc., to provide fundamental design data.

Both a cold and a hot chamber have been incorporated in the centre for carrying out development work on engine starting and on engine working in high ambient temperatures.

The total substation capacity is 750 kVA a.c. and 350 kW d.c. Also in the substation, linked with the test beds, are two sets of switchgear and equipment for running engine or turbines in parallel with the East Midlands Electricity Board when endurance runs of generating machinery of output approaching 1 MW are in progress.

The cost of the new research centre is estimated to be about £300,000 which includes new items of research equipment. One feature of design which will receive particular attention in the future is weight reduction. There has already been an appreciable reduction in the weight of the smaller types of machine and it is expected that there will ultimately be a reduction in the weight of larger types.

Mineral Insulated Cable Manufacture

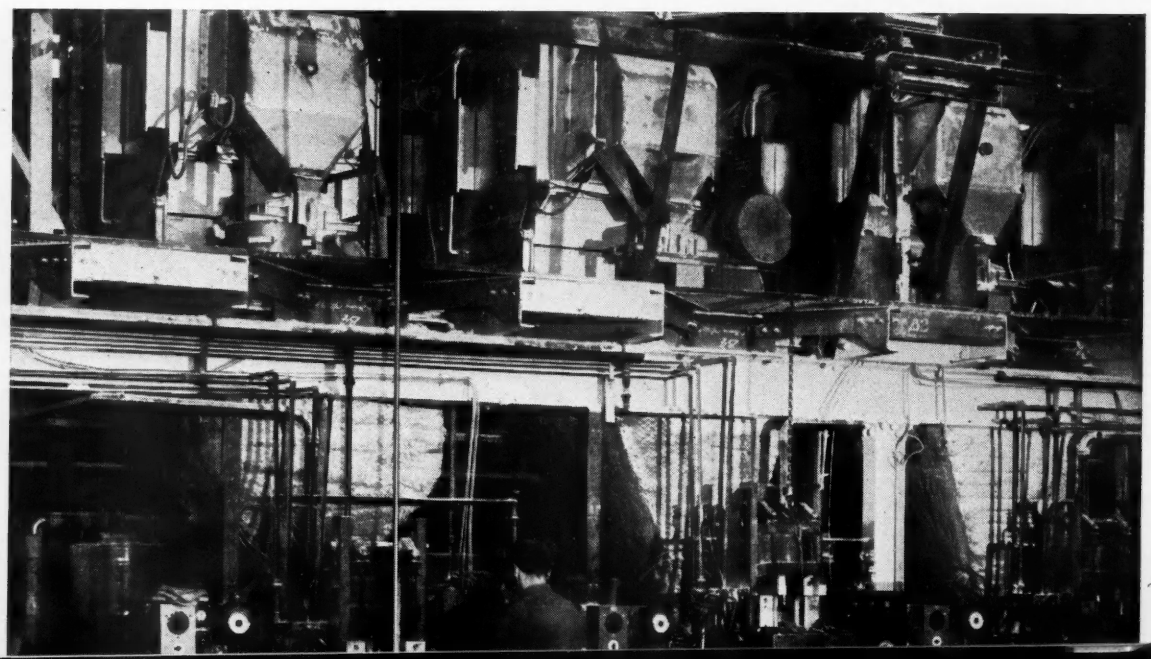
SELF-CONTAINED PRODUCTION PLANT AT PRESCOT

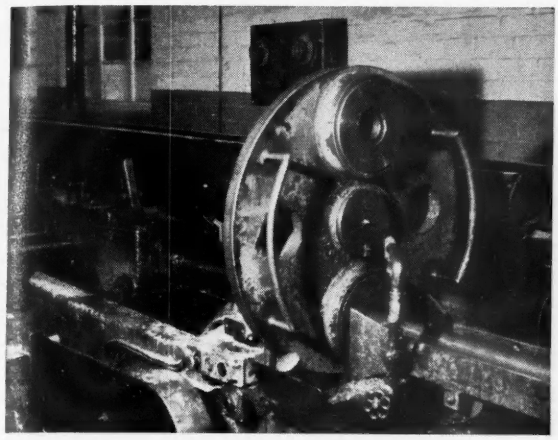
FOLLOWING the recent intensive research and development programme instituted by the C.M.A., British Insulated Callender's Cables, Ltd., erected at Prescot, Lancs., a large modern plant which is devoted exclusively to the manufacture of mineral-insulated cables. All the operations in the production of these cables, from inspection of the raw materials to packaging the finished products, are carried out in this self-contained unit.

This type of cable consists of solid conductors of high-conductivity copper embedded in highly compressed magnesium oxide, the whole being contained in a seamless, solid-drawn copper sheath. The filling of the copper sheath with highly compressed magnesium has been one of the most difficult problems encountered in the manufacture of m.i. cable. The company has developed a method which fills the tube automatically with insulant in powder form and provides the best solution of how to apply the insulant and yet still obtain flexibility in the finished cable.

The cables are made by first assembling a cable " start " which is very much thicker and shorter than the final cable. A " start " consists of copper rod, copper tube and magnesium oxide, the rods being held in the correct position within the tube by the powder which has been compressed around them. The final cable is obtained by drawing the " start " through a series of dies which reduce its diameter and at the same time increase its length. For example, a " start " 2in in diameter and 10yd long may be died-down to produce a finished cable of 0·20in diameter

General view of the plant used to fill m.i. cable "starts." Above the filling rams can be seen the powder hoppers and, above these again, the powder drying furnaces





The end of the "start" tube, which has been swaged to a "point," is gripped by a drawing dog and pulled along the drawbench through a die

and 1,000yd in length, the internal conductors being reduced in the same proportion as the outside diameter of the tube.

The filling and packing of the mineral powder into the space between the rods and the inside surface of the tube is carried out by a filling ram. This consists essentially of two parts: a ramming tool and a plug. The ramming tool is a steel tube smaller than the bore of the copper tube and it terminates in a head composed of three ribs and a guide. The guide is drilled in registration to take the start rods which can pass through it into the interior of the ramming tool. The plug is 6in long and is drilled at one end to correspond with the ram guide. It can be inserted into one end of the start tube and there locked into position.

Method of Manufacture

Before the actual manufacture of m.i. cable can commence, the tubes and rods are inspected, the rods are straightened and the mineral powder is dried in a kiln at a temperature of 850 deg C for three hours. After drying the powder is kept in moisture-free heated hoppers until required for use. The rods are placed in position in the tube by hand on a preliminary assembly bench. To commence filling the start tube, the whole assembly, with ram and rods inserted, is taken to the filling ram plant where it is held in a vertical position. Dried powder is poured into the gap between the ram and the start tube and trickles down to the ram head. The ram head is then lifted, so that the powder falls in front of it, and then thrust down, compressing the powder around the conductors. The ram is continuously lifted and thrust down, the tube being gradually filled with powder.

When the filling operation has been completed, the plug is taken out of the end of the tube and the empty end is hammered down to a reduced diameter by a swaging or pointing machine.

The filled and pointed tube is carried by conveyors to a drawbench where the point is thrust through the first die and gripped by a drawing dog which, in turn, hooks on to a moving chain. The tube is then pulled through the die. Drawing makes the copper become work-hardened and in order to soften it the cable is then passed through a roller hearth furnace which is filled with an inert gas to keep the copper bright.

After annealing, the cable is again drawn until it has grown to the length of the drawbench. It is then taken to another machine to be drawn in coil form. This machine is known as a bull block and may be used to draw the cable to very considerable lengths. The cable is drawn by using a large drum in place of a straight chain. As before, the copper hardens after drawing and the coils must be annealed in order to permit further processing. Annealing is carried out in a bell furnace, the coils are loaded on a carrier and covered with a retort or bell. The bell is in turn covered and heated by a large "lift-off furnace." In the course of its manufacture, the average m.i. cable will have been drawn twenty times and annealed at least ten times.

Each coil of cable is then subjected to a series of tests which comprise a twelve hour immersion in water, insulation, resistance, and high voltage tests. M.i. cable which has to withstand an atmosphere which is unduly corrosive is provided with a p.v.c. covering over the copper sheath.

Cable Characteristics

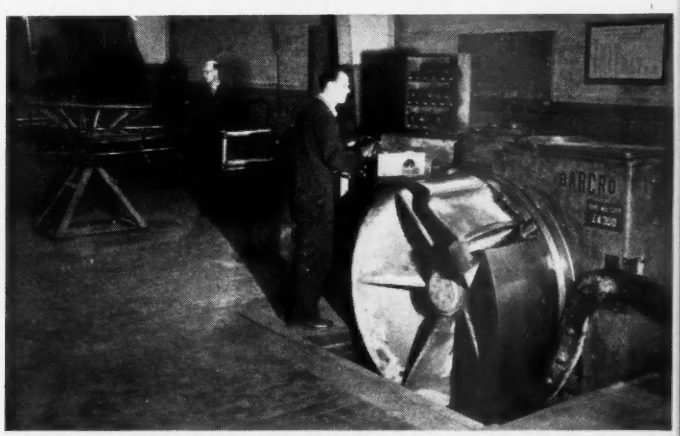
The factory produces mineral-insulated cables with up to seven conductors; the smallest has 0·0015 sq in conductors capable of carrying up to 16 A and the largest has 0·20 sq in conductors for up to 400 A. These sizes correspond to v.r.i. cables with 1/·044 and 37/·083 conductors respectively.

With this type of cable the conductor under normal conditions runs at almost the same temperature as the sheath. Thus, for a given current it is virtually true to say that the conductor will run almost as cool as a copper rod of a size equal to that of the whole cable. The main characteristics of a mineral-insulated cable are high resistance to heat, a capacity for carrying heavy current overloads, imperviousness to water, oil and gas, high insulation resistance, ability to recover after voltage breakdown and resistance to corrosion and ageing.

Although the ingress of water into the ends of m.i. cable can be rectified by heating the cable end, the best remedy is, of course, to eliminate the possibility of this happening. B.I.C.C. have now developed a moisture-proof seal which not only protects the cable against moisture but also prevents loosening of the powder at the ends, avoids a flash-over path at the magnesia face and provides each conductor with individual and flexible insulation.

Apart from the usual application of m.i. cable for installations where it is particularly important to have a fire-proof cable, there is now a growing demand for its use as a prefabricated cable cut to length, sealed and terminated ready for immediate installation.

A coil of m.i. cable is shown being reduced in diameter on a bull block



Power Factor Improvement as an Investment

By G. P. CUNDALL, B.Sc., A.M.I.E.E.*

MANY articles have been written on the various methods of power factor improvement but few have been devoted to the economics of the subject. This is surprising, because whatever technical disadvantages may accrue from a bad power factor a consumer's only reason for going to the expense of improving it is that he believes that in the long run improvement will pay. As a rule, the inducement to improve the power factor lies in the electricity tariff. Sometimes this states a value below which a penalty will be levied but above which no rebate is given. More usually no limit is fixed to the maximum power factor and the consumer is free to decide the value to which he will improve it. Herein lies the problem which it is the object of this article both to explain and to solve.

The only guide to power factor, which is given by text books refers to kVA tariffs and it is held in this article that the formula quoted by them is economically unsound. A criterion of judgment for the optimum power factor is suggested and formulæ given for its calculation under the principal forms of kVA and kW tariffs. The derivations of all equations and the curves used to illustrate the article are given in the Appendix. In a period of "credit squeeze," when the conflict of shortage of capital for investment on the one hand and high running costs on the other is difficult to resolve, a closer study of the nature of power factor improvement as an investment is worth while.

Since for the great majority of industrial installations capacitors are used for power factor improvement, for the sake of conciseness only they are referred to in the article but the general arguments advanced apply to all kinds of corrective equipment.

Nature of the Investment

An example will illustrate the nature of the problem. In it the simplest form of kVA tariff is assumed. Suppose there is a load of 300 kVA at 0·7 p.f. and the annual maximum demand charge is £6/kVA. The annual saving will be rather less than that indicated by the electricity bills because of the annual overhead charges attributable to the capacitors. On the assumption that these amounts to 10 per cent of the installed cost of capacitance, which is estimated to be £5/kVA, the consumer could be provided with the information in Table 1.

TABLE 1

New p.f.	Cost of improvement £	Annual saving £	Percentage return	Percentage return on last 0·01 of improvement
0·9	564	343	60·8	51·0
0·91	594	355	59·8	46·5
0·92	625	367	58·8	42·0
0·93	656	379	57·7	38·0
0·94	690	390	56·5	33·8
0·95	725	401	55·3	29·6
0·96	765	411	53·5	25·2
0·97	808	420	51·8	20·6
0·98	858	428	50·0	15·8
0·99	922	435	47·3	9·5
1·0	1070	433	40·5	−2·0

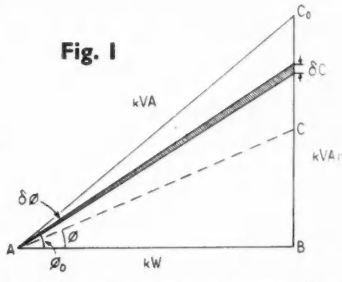
TABLE 2

Tariff	Optimum Value	Absolute Limit of Correction
kVA Demand	$p.f. = \cos\left\{\text{arc}\sin\frac{(rK+C)}{A}\right\}$ ..(1)	$p.f. = \cos\left\{\text{arc}\sin\left(\frac{C}{A}\right)\right\}$ ...(2)
kW Demand (i) Trig. Solution	$p.f. = \sqrt{\frac{rK+C}{Bp\sin\phi}}$ .....(3)	$p.f. = \sqrt{\frac{C}{Bp\sin\phi}}$ .....(4)
(ii) Graphical Solution	$p.f. = f\left(\frac{rK+C}{Bp}\right)$ .....(5)	$p.f. = f\left(\frac{C}{Bp}\right)$ .....(6)

A consumer whose only information was that a return of 40 per cent on his capital would be obtained by improvement to unity power factor, could be excused for investing £1,070 on such improvement. From Table 1, however, it is seen that the saving at 0·99 p.f. would be greater than at unity p.f. although the capital required would be £148 less. This clearly illustrates that the average rate of return on the total sum invested is not a sufficient guide to the choice of power factor.

The fifth column of Table 1 shows the average rate of return on the capital required to improve by the last increment of 0·01 p.f. This is seen to fall at an increasing rate and become negative between 0·99 and unity p.f. It is obvious that the extra £148 could not be justified by improving from 0·99 to unity p.f. and if 9·5 per cent were not considered a sufficient return on capital, the expenditure of £64 needed to improve from 0·98 to 0·99 p.f. could not be justified either. This example indicates that the reason for the choice of a particular final power factor should be governed by the rate of return offered by the last part of the investment.

Fig. 1



In the table the last part of the investment is the cost of the last 0·01 of improvement; a more accurate result would be obtained if the last part were the last pound spent. As an approximate guide, however, Table 1 shows that a consumer who demands a minimum return of 33⅓ per cent on any capital invested could improve to 0·94 p.f. whereas a consumer demanding only 25 per cent return could improve to 0·96 p.f.

A similar table could be prepared for any consumer but such a practice would be laborious and inexact. It is better that the reason for the diminishing rate of return be understood and a scientific method used for the calculation of the optimum power factor. The optimum power factor should be defined as that power factor which will offer not less than the minimum acceptable rate of return on the last pound invested. Having improved the power factor to that value, it should be maintained as close to it as is reasonably practicable by adding extra capacitance if the load increases.

First Principles, Tariffs and Costs

In an a.c. circuit the total power (kVA) is the vector sum of the active power (kW) and the reactive power (kVAr) and the power factor is the ratio of the active to the total power which is the cosine of the angle between the two vectors. The active power represents the work done or heat produced and the reactive power creates the magnetic

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fields in inductive machinery. By generation of the reactive power at or near the point of consumption generation, transmission and distribution equipment can be relieved from carrying reactive power and it is for this reason that supply authorities frame their tariffs in a way to encourage consumers to operate at high power factors. In Fig. 1 the power factor is improved from $\cos\phi_0$ to $\cos\phi$ by generating C_0C kVAr and the kVA is reduced from AC_0 to AC. The amount of capacitance required to improve the power factor from $\cos\phi_0$ to $\cos\phi$ is $AB(\tan\phi_0 - \tan\phi)$ kVAr.

Industrial tariffs usually take one of two forms. The first makes a charge for each kVA of maximum demand so that the cost varies inversely with the power factor. The second makes a charge for each kW of maximum demand together with a power factor variation charge. This variation is usually framed to offer equal savings for equal steps of improvement up to or from a specified figure.

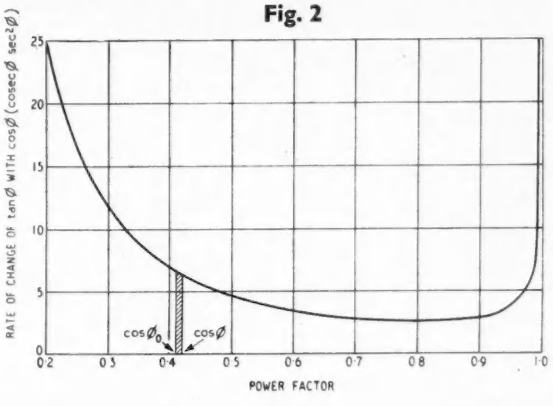
The overhead charges on capacitors consist mainly of depreciation and interest charges and, to a much lesser extent, on the costs of electrical losses and maintenance. The efficiency of capacitors does not deteriorate significantly during their normal life of about 20 years so that their value to the user is reduced on the average by only about 5 per cent of their original value each year. The capital cost will incur an annual interest charge rather higher than the current bank rate. Money set aside for depreciation will itself earn interest which should cover the small maintenance and electricity consumption cost. A total overhead allowance of about 10 per cent per annum should be satisfactory.

Mathematics of the Problem

The generation of a small amount of reactive power (Fig. 1) will result in a reduction of angle ϕ by $\delta\phi$. For a given load $\tan\phi$ reduces in the proportion by which the total kVAr is reduced but $\cos\phi$ does not change in the same ratio. The rate of change of $\tan\phi$ with $\cos\phi$ is illustrated in Fig. 2. The amount of capacitance required to improve the power factor between any two values is represented to scale in Fig. 2 by the area between them and the curve. It is evident that for a given small increment of improvement the least amount of capacitance is needed in the region of 0·81 to 0·82. In a kW tariff, which offers equal savings for equal steps of improvement, the highest rate of return on the whole investment will be obtained by improving to 0·816 p.f.

The charge under a kVA tariff is inversely proportional to the power factor and is therefore proportional to $\sec\phi$. If the curve of the rate of change of $\sec\phi$ with $\tan\phi$ were plotted against $\cos\phi$ it would be found to be sinusoidal with its maximum at zero p.f. and its minimum at unity p.f. Because of this every step of improvement made under a kVA tariff produces a smaller saving than the preceding step.

Fig. 2



The curve in Fig. 2 also illustrates the reason for the rapidly diminishing rate of return obtainable as the power factor approaches unity. Whichever tariff is in force a point is reached where the saving obtained by the addition of a further kVAr of capacitance is completely offset by the overheads chargeable to it. This point is usually defined in text books as the economic limit. Correction to such a value could not normally be justified, however, because the rate of return on the last part of the investment would be zero.

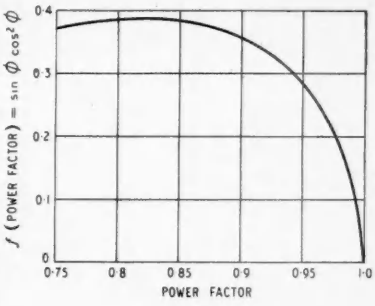


Fig. 3

Optimum Power Factor

The formulæ in Table 2 enable the optimum power factor to be calculated for either of the main types of tariff. They are compared with those giving the absolute limit of correction; i.e., the value at which the return on the last pound spent is zero. In the formulæ the following symbols are used:—

K = estimated installed cost of capacitors in pounds/kVAr.
C = estimated annual overhead charges in pounds/kVAr.
100 r = percentage rate of return required on the last pound spent.

In the case of a kVA tariff

A = annual charge of the last kVA of demand in pounds.

In the case of kW tariff

B = annual average charge per kW of demand in pounds.
p = percentage by which the kW demand charge is varied for each 0·01 by which the power factor differs from a given value.

The trigonometrical solutions of the equations are simple in the case of a kVA tariff but in the case of kW tariff they are more complicated. Solutions are readily obtainable, however, by calculation of the functional values (equations 5 and 6) and referring them to the graph in Fig. 3 from which the corresponding power factors can then be read. The use of the formulæ may be demonstrated by an example.

Suppose there is a load of 420 kW at 0·6 p.f. which is 700 kVA and that the annual charges per unit of demand are, in the first place,

For the first 200 kVA	£6/kVA
For the next 300 kVA	£5/kVA
For the rest	£4/kVA

and in the second place

For the first 160 kW	£7 10s/kW
For the next 240 kW	£6 5s/kW
For the rest	£5/kW

Under this tariff the total demand charge is to be increased by 1 per cent for each 0·01 by which the power factor is below 0·8 and reduced by ½ per cent for each 0·01 by which the power factor exceeds 0·8. The installed cost

of capacitance is estimated to be £5/kVAr and the annual overhead charges are estimated to be 10 per cent of the installed cost.

Under the kVA tariff the value to be attributed to A in the formulæ must be the price of the last kVA of demand. If the solution gives a power factor at which the demand is reduced so that the price of the last kVA is altered, the equation must be re-solved using the new value. Under the kW tariff the value to be substituted for B must be the average price/kW which is independent of the power factor. The value of p used must be that which is applicable at the final power factor. In the example therefore the values of the symbols will be as follows:—

K = 5
C = 0·5
r = 0·25
A = 4 for demands >500 kVA and 5 for demands between 200 and 500 kVA
B = 6·66 (Basic m.d. charge/kW m.d.)
p = 1 below 0·8 p.f.

Power factors to give returns of $33\frac{1}{3}$, 25 and 15 per cent on the last pound spent have been calculated and in Table 3 the costs are compared with those at the so-called economic limit and unity p.f.

The percentage return on the last pound at 0·8 p.f. is 41·2 but immediately after 0·8 p.f. the rebate drops from 1 to $\frac{1}{2}$ per cent for each 0·01 of improvement so the return falls to about 21 per cent, making returns of $33\frac{1}{3}$ and 25 per cent unattainable above 0·8 p.f. It will be noted that the difference in capital outlay between each required rate of return is sufficient to justify the analysis. Although the tariffs are comparable in that the charges at 0·8 p.f. are the same, the savings offered by the kVA tariff are far greater than those offered by the kW tariff.

It may be argued that because loads vary from month to month and the installed cost/kVAr of capacitance varies with the amount needed such an analysis could not usefully be made in practice but such an argument is not valid. Most engineering designs seem to be based on approximations to average conditions, but the designers are not absolved from making the estimates as accurately as they can. Designing a scheme for power factor correction is no exception. When the investment requirements are known, an approximate power factor can be estimated by using an approximate price/kVAr. A rough scheme can then be prepared and priced and the cost/kVAr checked. If the initial estimate is found to be too inaccurate a new power factor may be calculated using the new price/kVAr. Unless the new power factor makes a substantially different scheme necessary it will be unnecessary to check the price/kVAr again.

Conclusion

Power factor improvement should be regarded as an investment. It is the engineer's duty to explain the nature of the investment to the consumer who must then decide on his financial requirements. The optimum power factor, which is based on the rate of return on the last pound spent, may then be calculated. This is independent of the initial power factor and, unlike the so-called economic limit, will encourage improvement to it even if the existing power factor is close to it.

Where a kW tariff with a power factor variation clause is in force the highest rate of return on the total capital expenditure will be obtained at 0·816 p.f. unless the rate of variation is altered at a power factor below 0·816. Under a kVA tariff no particular power factor will give the highest rate of return because a smaller saving will result from each increment of improvement made. Because of variations in costs and tariffs generalisation is difficult but as a rule a kVA tariff will give more encouragement to power factor improvement than will a kW tariff.

TABLE 3

Percentage Return on Last Pound	kVA Tariff			kW Tariff		
	p.f.	Cost £	Annual Saving £	p.f.	Cost £	Annual Saving £
$33\frac{1}{3}$	0·9	1780	787	0·8	1225	437
25	0·937	2020	858	0·8	1225	437
15	0·97	2275	907	0·88	1667	507
Nil	0·995	2590	926	0·985	2430	577
−10	1·0	2800	920	1·0	2800	560

APPENDIX

With the exception of the second, the equations in Table 2 will be unfamiliar so their derivations are given here.

Using the symbols already defined:—The capital cost of improvement from $\cos\phi_0$ to $\cos\phi$ is $K(\tan\phi_0 - \tan\phi)$ and the annual overhead charges are $C(\tan\phi_0 - \tan\phi)$. Where there is a kVA tariff the saving in electricity bills is

$$A_0(\sec\phi_0 - \sec\phi_m) + A(\sec\phi_m - \sec\phi)$$

where $\cos\phi_m$ is the power factor at which the demand is reduced to a value which changes the price of the last kVA of demand from A_0 to A.

Where there is a kW tariff the saving in bills is:—

$$Bp_0(\cos\phi_n - \cos\phi_0) + Bp(\cos\phi - \cos\phi_n)$$

where $\cos\phi_n$ is the figure at which the power factor variation rate changes from p_0 to p.

Equation 1

The last increment of investment (say one pound) will enable the phase angle ϕ to be reduced by a small amount $\delta\phi$. The saving resulting from this will be $A\{\sec\phi - \sec(\phi - \delta\phi)\}$ and the overheads chargeable will be $C\{\tan\phi - \tan(\phi - \delta\phi)\}$.

The ratio of net saving achieved to the capital cost is:—

$$r = \left\{\frac{A\{\sec\phi - \sec(\phi-\delta\phi)\} - C\{\tan\phi - \tan(\phi-\delta\phi)\}}{K\{\tan\phi - \tan(\phi-\delta\phi)\}}\right\}$$

$$\frac{rK + C}{A} = \frac{\sec\phi - \sec(\phi-\delta\phi)}{\tan\phi - \tan(\phi-\delta\phi)}$$

The right-hand side of the equation will be recognised as the geometrical representation of the gradient of a function of which the general equation, as $\delta\phi \to 0$, is:—

$$\frac{d.\sec\phi.d\phi}{d.\tan\phi.d\phi} = \frac{\sin\phi}{\cos^2\phi}\quad\frac{\cos^2\phi}{1} = \sin\phi$$

So $$\frac{rK + C}{A} = \sin\phi$$

and $$\text{p.f.} = \cos\left\{\text{arc sin}\ \frac{(rK + C)}{A}\right\}$$

Equation 2

When the return on the last pound invested is zero r=0 and equation (2) may be derived by substituting r=0 in equation (1). The same result may also be obtained by another approach. Every previous pound invested will produce a positive return so at this power factor the annual saving is at its greatest.

The annual saving is:—

$$A_0(\sec\phi_0 - \sec\phi_m) + A(\sec\phi_m - \sec\phi) - C(\tan\phi_0 - \tan\phi)$$

which is a maximum when the differential coefficient with respect to ϕ is zero, i.e., when

$$-A \sin\phi \sec^2\phi + C \sec^2\phi = 0$$

$$\sin\phi = \frac{C}{A}$$

$$\text{p.f.} = \cos\left\{\text{arc sin}\left(\frac{C}{A}\right)\right\}$$

Equations 3—6

Using the same reasoning as for equation (1) the saving for the last increment of improvement is

$$Bp \cos\{(\phi - \delta\phi) - \cos\phi\}$$

and

$$\frac{rK + C}{Bp} = \frac{\cos(\phi - \delta\phi) - \cos\phi}{\tan\phi - \tan(\phi - \delta\phi)}$$

$$\frac{rK + C}{Bp} = \frac{-d(\cos\phi).d\phi}{d(\tan\phi).d\phi}$$

$$\frac{rK + C}{Bp} = \sin\phi \cos^2\phi$$

and

$$\text{p.f.} = \sqrt{\left(\frac{rK + C}{Bp \sin\phi}\right)}$$

The simplest algebraical solution to this equation is obtained by a method of approximations. In Fig. 3, however, $\sin\phi \cos^2\phi$ is graphed against $\cos\phi$ which enables the power factor corresponding to the calculated value of $(rK + C)/Bp$ to be read directly.

The derivations of equations 4, 5 and 6 are similar to those already given.

Maximum Rate of Return and Return at Unity P.F.

Considering the maximum rate of return under a kW tariff, Fig. 2 shows that the least amount of capacitance for a unit step of improvement is required in the region of 0·81–0·82 p.f. Provided the power factor variation is a constant and does not alter at a lower value as in the example chosen the highest rate of return, both on the last pound spent and on the total sum invested, will be obtained at 0·816 p.f. This value may be calculated as follows:—

The curve in Fig. 2 represents the rate of change of $\tan\phi$ with $\cos\phi$ which may be expressed as:—

$$\frac{d}{d(\cos\phi)} \tan\phi = \frac{d.\tan\phi.d\phi}{d.\cos\phi.d\phi}$$

$$= \text{cosec}\,\phi.\ \sec^2\phi$$

This is a minimum when:—

$$\frac{d}{d.(\cos)} \text{cosec}\ \phi\ \sec^2\phi = 0$$

i.e. when $d.(\text{cosec}\,\phi \sec^2\phi).d\phi = 0$

Differentiating:

$$\frac{2 \sin^2\phi \cos\phi - \cos^3\phi}{\sin^2\phi \cos^4\phi} \cdot \frac{1}{\sin\phi} = 0$$

$$2 \sin^2\phi \cos\phi - \cos^3\phi = 0$$

$$2 \sin^2\phi - \cos^2\phi = 0$$

$$2 \tan^2\phi - 1 = 0$$

$$\tan\phi = 0{\cdot}707$$

$$\text{and } \cos\phi = 0{\cdot}816$$

Turning now to the rate of return on last pound at unity p.f., for the two different forms of tariff considered

$$\frac{rK + C}{A} = \sin\phi$$

and

$$\frac{rK + C}{Bp} = \sin\phi \cos^2\phi$$

At unity p.f. $\sin\phi = 0$, so in either case $(rK + C) = 0$.

In the example quoted therefore:—

$$r = -\frac{C}{K}$$

$$= -\frac{0{\cdot}5}{5}$$

$$r = -10 \text{ per cent}$$

Precise Measurement of Distance

A NEW system of micro-wave measurement of distance has been introduced into this country by Cooke, Troughton & Simms in conjunction with Tellurometer (Pty.), Ltd., of Cape Town. The invention of a South African, Mr. T. L. Wadley, the new "Tellurometer" has a range of at least twenty miles which will make it of great value in surveying, civil engineering and construction works of a major nature. The instrument is being manufactured by Tellurometer (Pty.), Ltd., and will be marketed by Cooke, Troughton & Simms in Britain, Europe and all dependent territories, India, Pakistan and Ceylon.

The "Tellurometer" being demonstrated by the inventor

The "Tellurometer" system operates in the 10 cm wavelength region and measures the travel time of radio waves over the length to be determined, with an accuracy of a fraction of one thousand millionth of a second. Measurements can be made by day or night and visibility is immaterial. In general, optical line of sight is required over the length to be measured.

To measure a single line, one master station and one remote station are necessary. Measurements are made from the master station and an operator is required at the remote station. A built-in duplex radio telephone circuit is included in the system and is used in the measurement procedure. If a number of remote stations are employed, a number of lines may be measured from the master station in the course of one setting up. The instruments at master and remote stations are physically similar, but are not interchangeable. Both the master and remote instruments are self-contained units with built-in aerial systems.

The accuracy of the instrument is such that the distance between London and Reading could be measured with an error not likely to exceed six or seven inches. The instrument has a range of 500ft to 100 miles, but for practical purposes the maximum working range is about 35 miles.

ELECTRONICS — A FACTOR IN INSTRUMENTATION

SOME PRESENT AND FUTURE DEVELOPMENTS

A FEATURE of the Instruments, Electronics and Automation Exhibition, which has been open for the last ten days at Olympia, London, and of which we gave an account in last week's *Electrical Review*, has been a conference at which twenty-four papers were presented. These embodied general reviews on such subjects as what the future might produce; nuclear power; instrumentation in its many aspects; and communications and education. In addition, time was devoted to more detailed accounts of specific techniques and applications in these fields. Those attending were therefore enabled to provide themselves with a background of principles to what they had seen in the exhibition, even when, as was the case in some instances, the descent from the general to the particular was so abrupt as to detract somewhat from the educational value of what was said.

The New Age

No such criticism could, however, be made of Lord Halsbury's remarks in dealing with "The New Age" at the opening meeting. Control, he said, lay at the heart of all the wonders of the modern world, such as jet propulsion, guided rockets, nuclear power, thermo-nuclear fusion, television, object detection, radio-navigation and programmed machine tools; and this increasingly meant electronic control. To obtain this control comparatively little power was required. In fact, if electronic equipment was compared with mechanical devices for achieving the same purpose it would be seen that the former liberated the designer from the awkward question "Can it be made?" The answer usually appeared to be "Yes." Not only could it be made, but it could be economically serviced without being "un-made." This was a very important factor as one part could be replaced by another and operation resumed with the minimum delay.

To remove any sense of obscurity as to what occurred inside the innumerable black boxes which were on display in the exhibition they might start with the fundamental physical quantities of length, mass and time and with their numerous derivatives. They would next have to think of all the electrical and magnetic quantities. This would include the basic work that had been done by amplifiers and function generators of different kinds. A third category would consist of power output devices which were linear in the geometrical rather than the mathematical sense.

Fifteen Years' Time

Looking forward to what we might expect to find at a similar exhibition in 15 years' time, Lord Halsbury predicted that there would be a greater use of semiconductors. The 10 Mc/s transistor would be standard practice and the 100 Mc/s transistor would be coming into use. The part played by power transistors would be correspondingly increased. There would also be a growing use of devices in the super-conductive zone and in two-dimensional structures, such as printed circuits. The economics of the latter was interesting since, although they might not cost less than conventional wiring, they might lead to important advances in computer construction. There had already been experiments with magnetic films for the storage of information, but the problem was to manufacture them, and he had a feeling that the whole thing might be printed. A further problem was the building of the two-dimensional crystal, while another thing needed was a multi-cascade element to drive three or more cores. If that could be done the power devices required could be reduced.

Computer-Controlled Machine Tools

In dealing with computer-controlled machine tools, Mr. J. N. Toothill said that in 1951 Ferranti's had begun to worry about the problem of making complicated components in small quantities and in so doing to match a large development team with sufficient skilled labour. To illustrate the success of this policy he described the control of machine tools for a continuous counting process and the use of servo-control on tools operating from a magnetic tape. A special-purpose computer that had been designed to reduce the cost of planning and the production of tapes was also mentioned. In this connection the transfer of information from an engineering drawing to a tape was the critical phase in the ability economically to carry out continuous milling in any form.

Mr. Toothill then showed a film demonstrating that there was a saving of time of more than five to one in favour of the tape-controlled machine compared with the conventional pattern so that skilled labour could be concentrated on planning. If the tool had to be controlled to within 0·001in the related servomechanism must be designed to receive considerably more than 1,000 pieces of information for every inch the cutter had to travel. This information had often to be very detailed and the most rapid method of producing it accurately was by a special-purpose digital co-generator.

Electronically Controlled Boring

Mr. C. A. Sparkes described a horizontal boring machine with electronic co-ordinate setting. The importance of this development could best be realised by recording the fact that for every shaft produced a support bearing of some form must be provided and this generally meant a drilling, boring or similar operation often with holes at closely controlled centres. The machine, which was now in service, was capable of carrying components weighing from a few pounds to over two tons and of machining holes to centres within 0·0005in. As the control system was intended purely for co-ordinate setting, a simple measuring device was used. This consisted of a bar of magnetic material carrying a number of 1in blocks, each of which was bored and filled with a non-magnetic insert. The machine was operated by a standard punched card which pre-set twelve dials on a control desk, enabling the corresponding figures on the drawing to be checked. Very few electrical troubles had been experienced and these had been dealt with by the normal staff. Of the two mechanical breakdowns that had occurred one illustrated the advantage of designing the measuring system to check the functioning of the machine.

Experience with other machines of this type, which had been installed in a shoe-making factory and for producing packing machinery, had been favourable and it was

believed that the further use of electronically controlled tools would show the production engineer how a component could be machined which was correct the first time.

Mr. J. Loxham said that the main object of automatic gauging was to increase the reliability of the inspection process. He illustrated this by showing slides of a machine in which ten or twelve dimensions could be inspected simultaneously. The same kind of gauging element was used throughout, the results being indicated by means of signal lights. In another more complex machine the 32 dimensions of a compressor blade for a jet engine could be measured simultaneously the results being indicated on a system of manometer tubes. A machine for inspecting simultaneously 56 dimensions of a crankshaft was also illustrated, the tests including the examination of roundness, eccentricity and squareness of face.

Nuclear Power

Sir Claude Gibb's address on " Nuclear Power " opened on the realistic note that in Britain there was a growing shortage of the coal upon which our industry had been built. Quite apart from Nasser, it would be suicidal for us to correct this by becoming dependent on oil to such an extent that we had to go to war to obtain it. The alternative was nuclear power, in the industrial development of which Britain held a commanding position, so that our engineers were able to go ahead with the construction of quite large power stations. In fact, by 1965 about 25 per cent of the electricity generated in Great Britain would come from nuclear power and by 1975 we should no longer be building coal or oil-fired stations.

After emphasising that there was no danger, no effluent and no radioactivity from a nuclear power station of the type that was being built in this country, Sir Claude went on to say that the break with traditional fuel would mean a break with traditional appearance. He illustrated this by showing slides of the station which was being constructed at Bradwell on the River Blackwater, where dignified buildings would be encased in aluminium and the heat exchangers would be in glass structures. This would avoid spoiling the countryside and would enable power to be continuously available. Bradwell and the other new nuclear stations would be " optimised " for the production of electricity. Cooling towers would not be needed as river water would be available.

Reactor Economics

The graphite-moderated gas-cooled reactor had to have a fairly large electrical output to be economic. While the cost per kW installed in a nuclear power station was double that of a coal-fired station the fuel cost was less than half and operating and maintenance costs were about the same. Even at present the cost of energy from a nuclear power station would certainly not be more than 10 per cent in excess of that of a coal-fired generating station and by 1965 would be less.

He hoped the Government would have courage to go ahead with nuclear power stations without waiting to see if they would work. They would work. The problem was more one of engineering than nuclear physics and more one of metallurgy than engineering. We were limited in gas temperatures and thus to steam conditions of 730 lb/sq in and 703 deg F. It would be necessary to deal with nearly 50 per cent of water in the last stage of the turbine and this would bring back problems against which we had been fighting for 30 years. To avoid this at the new stations a second supply of steam at a low pressure, but at the same initial temperature, would be injected at one of the later turbine stages and the moisture in the last row of blades thus controlled.

In reply to a question whether it would not be worth while to heat the steam in a separately heated superheater as had been done at Shippingport in America, Sir Claude pointed out that this was an unnecessary complication. Although a 5 per cent increase in cycle efficiency was obtained at the expense of an increase of 1 per cent in electricity consumption the overall cycle efficiency was only 24 per cent, while that at Bradwell would be over 28 per cent.

Two lectures on reactor control were delivered by members of the staff at Harwell. In the first of them Mr. R. J. Cox described a reactor of the swimming pool type in which the uranium fuel elements were suspended in a concrete tank containing purified water. Along one side of the reactor and at one corner the concrete shielding was replaced by an aluminium window through which measurements could be made of the attenuation of various forms of radiation. The main task of this reactor was to assist in the development of the British submarine propulsion unit.

In the second paper Mr. J. W. Walker said that reactor control required the simultaneous solution of a large number of differential equations and for this purpose the analogue computer was more accurate than the digital computer. Another important application was the determination of the critical size of a reactor for proper operation before it was built. This applied to both internal and external conditions.

In the operational field computers could play a useful part in providing an estimate of some variable which was important but could not be measured directly and where its calculation became unwieldy. They were also useful for training purposes as they accustomed the operator to the " feel " of the apparatus.

Radio Isotopes in Nucleonics

Dealing with the uses of radio isotopes in the nucleonic industry Dr. H. Seligman described a thickness gauge consisting of a source of radiation and a detector with the material to be measured between them. The thicker the material the less the radiation that would be transmitted and by a simple measurement a conclusion could be reached as to its density. Thickness measurements could also be based on the scattering of radiation and the same method could be used for the determination of corrosion. Radioactive methods, too, could be employed for the elimination of static electricity, and for the measurement of wear and leaks.

A development in the nuclear industry, which had not yet been started in practice, was the analysis of materials. Examples of this were the determination of the amount of selenium in glass and the discovery of the place in the continuous casting of aluminium where the solidification boundary was formed. The nuclear power programme would cause large amounts of fission products, such as cæsium 137 and strontium 90, to become available. If these could be removed during the working-out process of the fuel elements not only would the problem of their disposal be solved, but they could be used for sterilising food and medical supplies as well as for the destruction of pests and the irrigation of certain plastics, such as polyethylene.

A Career with a Future

Dr. P. Dunsheath, in an address at the " Education Day " of the conference, expressed his disappointment that not more had been done in the exhibition to bring home to young people the advantages of a career in the instru-

ments industry which had many attractions to offer to the boy or girl leaving school or university. In fact it was not unreasonable to claim that there was more intellectual interest in a thousand pounds' worth of scientific instruments than in the same value of product in almost any other industry. So long as science continued to advance there would be an ever-increasing call for electrical instruments in which convenience and reliability were combined with the most fantastic accuracy and sensitivity. There was little chance that the designer and manufacturer of these devices would ever find themselves without ideas to develop and needs to fill.

The demand for skilled young men in this field was great and in organising their education and training as well as in bringing before them the many advantages of such a career the industry would be serving not only itself but the whole community. We were living in a scientific and technological age which was making new demands on education and it was our duty to see this was understood. After describing methods by which entry was possible to prospective technologists and the courses of training available Dr. G. L. D'Ombrain went on to discuss the widely held opinion that the way to the highest ranks of top management was as a lawyer, accountant or actuary and not as an engineer. In support of his argument he gave figures of the starting and ultimate salaries payable to fully trained technologists and said that it was essential to the healthy future of British industry that these should be increased. One reason for the present position was that not one in a hundred of the public knew what a technologist was; and it was not surprising that so little was thought of engineers if engineers did not think much of themselves.

Summaries of further papers will appear in next week's issue. The E.I.A. Exhibition closes this evening. During the first week (up to last Saturday) the number of visitors was over 23,000 of whom 1,250 came from sixty-seven overseas countries.

FUTURE COPPER SUPPLIES

AN optimistic view on the future of the world's copper resources was expressed by Mr. H. J. Miller in a lecture to the Utilisation Section of the Institution of Electrical Engineers on 9th May. Statements expressing fear about the world's supplies of copper had from time to time been given much publicity, particularly as certain influential authorities had subscribed to depressing views, he said. Certainly the electrical industry, which was the largest consumer of copper, should not be hampered in development projects by what would appear to be unfounded fears of a copper famine in the near future.

There had for long been a relationship between the growth of the electrical engineering industry and that of copper production. The one could not have advanced without the other, and there was almost this same dependence to-day. It would appear that the proportion of copper which was consumed by the electrical industry in one way or another was not far short of half of the total supply.

Since Weed in the United States in 1907 pronounced anxiety about copper supplies, others had made alarming statements, and with frequent repetition probably the position of forthcoming shortage had come to be accepted, particularly in periods of temporary difficulties of supply, caused by sudden bursts in the rate of industrial activity which could not be accompanied by equal rates of increase of primary metal production.

Mining companies published their ore reserves, but these were proved amounts only. It was satisfactory for a mine to operate with only a few years of proved reserves, and many instances could be quoted of mines which had operated for over forty years with never more than ten years' life in sight at any one time in their histories. The production of newly mined copper was supplemented by large quantities of recovered scrap metal, a steadily increasing source of supply.

Primary copper production had been subject to many abnormal influences, giving rise to sudden variations in demand and hence in production rates. From a position of marked excess production at the end of the last war there was soon a marked shortage, because of the continued heavy demand for industrial consumption and strategic stockpiling, and disturbances at mines and in transport. Large price movements had been necessary to achieve a balance, these being quite out of proportion to the small shortage.

"Old scrap" provided quantities which were unpredictable, and yet were not so unstable as might be thought. It was possible that this contribution amounted to about 20 to 35 per cent of the primary metal consumption.

Mr. Miller surveyed the position of copper production in individual countries, drawing attention in particular to the steady expansion of output in Rhodesia, Canada and the Belgian Congo. There was also assurance in the not-too-distant future of a great increase in output from Peru. In production and rate of expansion Russia had been outstanding, with a performance roughly comparable to that of Rhodesia in about the same period of time.

There was every possibility that the near future would witness a vigorous growth in both the production and consumption of copper. The key factor was demand which was difficult to assess with certainty. The American Paley Report in 1952 concluded that world production of primary copper in the period 1950-57 must be increased from 2,500,000 to 3,850,000 (short) tons. Since American production was expected to decline slightly, that of the remainder of the world had to be approximately doubled. There had been a good start towards the target. Reserves of copper were amply sufficient to support the enlarged programme, and in the light of past experience the reserves were expected to increase year by year, at least for a long time to come. Secondary copper arisings would increase at a greater percentage rate than virgin metal production.

It was regrettable that consumer interests had not been able to present much more stable requirements. Variations in requirements greatly distorted the picture from the primary metal producers' standpoint, for the simple reason that the primary producers, in effect, were only required to produce the difference between the total demands and the supplies from secondary sources. Thus they were exposed to a distorted demand, and it was small wonder that supply and demand got out of step. There were abundant reserves of ore for the next fifty years with the prospect that at the end of that time the proved reserves would still be ample.

The chairman of the Section, Mr. H. J. Gibson, presided at the meeting.

B.E.A.M.A. Education Conference

PRACTICAL EXPERIENCE AND SUGGESTIONS

THE Government's plans for the expansion of technical education place much emphasis on the contribution that will be required from industry. Not only does the success of the proposals for sandwich courses, the extension of the system of day release, and the multiplication of the part-time technical courses largely depend on the support of managements, but there is also much scope for the provision and extension of technical training facilities within industry itself.

With the object of sharing the experience gained by both large and small firms in the running of training schemes over many years, and to foster co-operation between firms, the B.E.A.M.A. Education Committee held a one-day conference at the Royal Festival Hall on 8th May. The conference, which was under the chairmanship of Mr. J. O. Knowles, M.A., M.I.E.E., chairman of the B.E.A.M.A. Council and of the Education Committee, was attended by over 100 education officers and executives from member-firms of the Association. There were also a number of guests from bodies, such as the I.E.E., closely associated with education in the electrical industry.

In his opening remarks, Mr. Knowles said that they were concerned in building up the future human capital on which the competitive position of this country depended. One of the questions they had to ask themselves was whether the recent changes in education were what they wanted. It was, however, not enough merely to train personnel, they must also ensure that they were not misused when they were in industry. A technician, he pointed out, was not a failed technologist, nor was a technologist necessarily a good technician. Both had specialist skills that must be properly used and fostered.

Significant Changes

Before presenting the first paper on "Recent Developments Affecting the Patterns of Craft, Technical and Technological Training," Mr. C. Grad, A.M.I.E.E. (manager, Education Department, British Thomson-Houston Co., Ltd.), paid tribute to the work in this field of Sir Arthur Fleming, who was chairman of the B.E.A.M.A. Education Committee from 1917 until last November. During the past four years, Mr. Grad said, rapid changes in education had occurred. So far they had mainly affected the larger organisations, but they were now spreading to the smaller firms. One of the most significant of these changes was the growing interest in science in the schools. Over 60 per cent of boys in the sixth forms of grammar schools were now taking mathematics, physics and chemistry.

Two other important changes were the recognition of the status of the technician and the demand for more courses, and the re-organisation of existing courses, to meet the demand for trained personnel. The introduction of sandwich courses had been anticipated by the larger firms, and the first men trained in this way would be completing their courses next year.

Referring to the craftsman apprentice, Mr. Grad said that a properly organised training workshop could more than halve the time taken to impart the necessary skills, and, furthermore, it was possible at the same time to provide extra instruction. The new course which the City and Guilds of London Institute was setting up for electrical craftsmen was a great advance on the previous wireman's course which was all that had been previously available.

The greater part of the discussion on Mr. Grad's paper centred on the problem of the right age and method for the selection of boys for craft and technician apprenticeships, and of the importance of providing opportunities for subsequent transfer from one course to the other, both up and down. Mention was also made of the vital need for making known to schools the opportunities that existed in industry and the qualifications that were required for entry at the various levels.

Sir Ronald Nesbitt-Hawes (chief education administrator, English Electric Co.) presided at this session.

Women in Industry

With Miss M. Bell (president, Women's Engineering Society) in the chair, Mr. G. S. Bosworth, M.A., M.I.E.E. (chief technical personnel and education officer, English Electric Co.), introduced the subject of "The Training and Employment of Women at Technical Level." In the course of his address Mr. Bosworth said that social and economic pressure was making women seek employment and there was a large untapped reservoir of suitable girls for technical positions. Science training in girls' schools was weak largely because of the lack of suitable teachers—a position which should be remedied. Most women technicians in industry had not received a formal training. Those few graduates who were in technical positions were of a high level and possessed the pioneering spirit. They involved but small expenditure on the part of industry but if they were to be fitted for higher technological work money must be spent on assisting them.

Recruitment of girls from areas outside a firm's district entailed a number of welfare problems which became the firm's responsibility. Another point was that it was difficult to provide both for those girls who wished only to get to a certain point and those who wanted to go on.

Speakers in the discussion dealt with such matters as whether industry would accept women for the highest positions and the wastage through marriage after money had been spent on training. It was suggested that women graduates need not be given such intensive or extensive courses as men and one speaker asked whether the I.E.E. would lay more stress on vocational training than on workshop training as qualification for membership. Another speaker thought that the possibility of giving women greater responsibility and employing them on overseas contracts should not be ruled out.

Training of Technicians

Mr. W. H. Temple (personnel controller, G.E.C.-Osram Group) presented a paper on "The Training of Technicians in the Medium-sized Firms." Mr. A. J. Nicholas, O.B.E. (managing director, South Wales Switchgear, Ltd.), took the chair and said that industry depended a great deal on the technicians—the "N.C.O.s"—and the most suitable of them could go to higher levels.

Mr. Temple said that technicians formed a broad category between the skilled craftsmen and professional engineers and it was necessary to institute courses especially for their training. They needed a good

knowledge of workshop practice and ability to supervise skilled craftsmen, as well as a general knowledge of engineering principles.

The employer should first examine the type of job which was required to be done by a boy and then suitable training should be devised. There should be an initial period of common training; then aptitude and ability should be assessed for more specialised training. One day a week should be spent at a technical college. It was difficult to divert a boy from a course for which he was unsuited to a more appropriate one.

Draughtsmen who wished to be designers must have full practical training if they were not to set the production department very difficult problems and if sound design and economy were to be achieved.

Contributors to the discussion thought that the door should be open to all classes of boy irrespective of the results of the "eleven plus" examination, although that was a good guide to a boy's abilities. One speaker thought that older men, without formal certificates, should be given the opportunity of becoming technicians but another pointed out that such men probably had family responsibilities which necessitated a job with adequate pay. The importance of describing a job accurately before attempting to select men for it was stressed. Mr. Nicholas mentioned the possibility of recruiting suitable people from other industries.

Mr. Knowles presided at the luncheon and introduced Sir Gilbert Flemming, K.C.B., Permanent Secretary, Ministry of Education. In a few remarks Sir Gilbert said that the industry and his Ministry had worked very happily together. The organisers of the Conference had obviously chosen the most burning questions for discussion, particularly the employment of women. On behalf of the Ministry and the community he thanked the industry for its educational work.

Scottish Training Scheme

The first of the two afternoon sessions was devoted to a paper on "Joint Training Schemes in Medium-Sized Firms," by Mr. J. E. C. McCandlish (secretary of the Scottish Electrical Training Scheme) who described this scheme. It had been established at the end of last year with the object of reducing the number of electrical engineers who were lost to Scottish industry because they had to come to England for their practical training. At present the scheme embraced five medium-sized manufacturers and the two Electricity Boards, and training could therefore be provided to I.E.E. requirements in light and heavy manufacture and in operation. Pre-college, vacational and two-year post-graduate courses were now provided. A student was selected by the S.E.T.S., and paid by them throughout his training, but after the first year of the post-graduate course a "marriage" would be arranged with the member-firm with which he would take up a permanent appointment, and his training planned accordingly. In this way no more students were taken on than there were jobs available.

Although the scheme was immediately concerned with students who graduated in electrical engineering in Scotland, it was hoped later to offer facilities to graduates in mathematics and pure science who wished to qualify as chartered electrical engineers, and also to students from overseas.

In opening the discussion, the chairman, Mr. E. L. G. Robbins (managing director, Industrial Administration (R. & A.), Ltd.) said that in the schemes organised by his company for the Engineering Industries Association an apprentice or student was sponsored by a single firm from the start, although he might work in many firms during the course of his training. There were now ten E.I.A. groups in London and the Midlands and courses were provided for craft, technician, student and graduate apprentices.

Mr. J. Oldroyd, secretary of the Education Committee and of the B.E.A.M.A., said that this paper spotlighted the real point of the conference. In the past most engineers had obtained their technical training with one of the larger firms. These could not, however, continue to train substantially more than they needed for their own requirements, and a greater contribution would therefore have to come from the smaller firms through co-operative schemes.

Sandwich Courses

At the final session with Dr. J. S. Tait (principal, Northampton Polytechnic) in the chair, Mr. R. F. Marshall, B.Sc., A.M.I.Mech.E. (manager, Education Department, Metropolitan-Vickers), described in some detail the "Problems and Costs of Industry-Based Sandwich Courses." In the preparation of these schemes it was most important, he said, that there should be close co-operation with the technical colleges, who were the final arbiters in the selection of students. The double sandwich course was a problem for the colleges, but industry could help by the provision of part-time lecturers. The double sandwich also benefited the smaller firm, as all the students were not away at the same time. In his own firm, Mr. Marshall said, the crush of students in the works in August and September was reduced by encouraging them to apply for unpaid leave to study abroad.

A student should be encouraged, he thought, to take part in the corporate life of both the college and the works, and undertake more liberal studies. For a boy who entered with G.C.E. at "A" level the cost of training in a five-year sandwich course would be about £1,800, while the 5½-year course required by a boy entering at "O" level would be from £2,000 to £2,200. A greater integration of theoretical studies and factory work could be ensured by technical college lecturers spending a long vacation or the works half of a sandwich scheme in the factory.

In reply to the discussion, which was concerned mainly with the cost of training and the continuation of studies during the works period, Mr. Marshall emphasised that students who left the firm at the end of their training should not be considered as lost. They often settled abroad and became our best trade ambassadors.

Summing up the conference, Mr. Knowles said that they had had a most successful day. He thought they need not be afraid of the big battalions of the United States and Russia, but could have faith in the British combination of theory and practice. The conference had shown that there was a great opportunity for the medium-sized firms to show initiative in helping to provide facilities for training the growing numbers essential to the future expansion of the electrical industry.

Reactor Technology Training

THE next reactor technology courses specially arranged for senior technical executives will be held at the Reactor School, Atomic Energy Research Establishment, Harwell, from 21st to 31st October next and from 6th to 16th January, 1958. These will be the first such courses for senior executives open to overseas as well as British students. The fee for a course is £50 (excluding accommodation). Selection of the students will be made three months before the start of each course. Further information can be obtained from the Reactor School, Atomic Energy Research Establishment, Harwell, Berks.

Invention and Nature

I.E.E. MEASUREMENT AND CONTROL SECTION LECTURE

AT a meeting of the Measurement and Control Section of the Institution of Electrical Engineers on 7th May Mr. F. W. Meredith, B.A., delivered the annual lecture entitled "Invention and Nature." He said that since an organism achieved its performance by physical means, it was not really surprising that man could achieve a similar result by analogous means. Whereas, however, man sought to achieve his ends by simple arrangements containing a minimum number of the components which had to be individually fabricated, nature worked with an almost astronomic number of cells and achieved its results by the organisation of their mutual interaction; the human brain contained some 10^{10} cells.

Man achieved automatic volume control, to deal with variability of the strength of an incoming signal, by feeding back a potential to the grid of a single variable gain valve; nature achieved the same end by the co-ordination of a number of motor nerves used to activate muscles to control the tension of the eardrum or the iris diaphragm of the eye. One component, widely used by man, which had no counterpart in nature was the wheel. There was a very good reason for this omission; it was impossible to maintain continuity of feed lines across a limitless bearing and nature wisely avoided dry contacts on signal lines.

Physical Regulators

The simplest application of a servo-mechanism was a regulator, of which the earliest known example was the Watt's centrifugal governor, the significance of which was recognised by Clerk Maxwell. But the physiologists soon pointed out that it was but a mechanical analogue of the reflex circuits of sense organs, nerves and muscles. Temperature and other vital conditions in the body were stabilised by the now familiar combination of a transducer to sense the disturbance or error and convert it into an electric signal, a responder (or several responders) to counter the disturbance, and a coupling by which the signal from the former modulated the latter. To these unconscious regulators was owed the freedom from vulgar chores of the higher centres of the brain which enabled them to indulge in intellectual activity.

Man's invention of echo sounding occurred at about the same date as the recognition of the natural device by which bats navigate by echo with binaural directional sensing. This was a frequent feature with these analogies. The coincidence appeared to arise from the state of the climate of knowledge in which a particular line of thought was likely to occur. Man had enormously extended the scope of utility of the pulse sounding technique by the use of electromagnetic waves instead of acoustic waves, but the bat varied its pulse frequency with range to get more frequent clues at short range. The high transmission speed of radar made this variability unnecessary so far. But perhaps, as flight speed increased, some day man might have to emulate the bat in this respect.

Bees could sense the sun's direction from a very limited view of blue sky or a larger view of overcast sky. Von Frisch established that the bee responded to the direction of polarisation of light from the sky. About the same date, and apparently without knowledge of these facts, the Pfund sky compass, an apparatus with an orientable polarising screen, was invented for navigation during the Arctic twilight.

In its halteres (modified vestigial form of the second pair of wings), the fly possessed a gyroscopic three-axis control, and significantly, for the most important function, stabilisation in yaw, it made use of the large amplitude of the halteres to provide double frequency signalling, which almost certainly aided discrimination of the signal. The field appeared to be wide open for an inventor to follow the example of the fly and produce a practicable vibrating gyroscope.

Mr. Meredith ended his survey of the analogies between the works of nature and the inventions of man with a discussion of the so-called "electronic brains." Such machines, in conjunction with feed-back controls and transfer machines, spelt automation, which would transform the whole pattern of society. Russia had already pioneered in the field of the automatic factory with a piston plant set up in 1950. Mr. Meredith described the adaptive mechanical models of Dr. Ross Ashby and Dr. Grey Walter. The latter set out to produce a mechanical "animal" with the faculty of Pavlov's "conditioned reflex" by which an animal learns to associate, for example, the dinner bell with dinner. At first, the idea of association of two stimuli which commonly occurred together might seem comparatively simple to simulate. But Grey Walter found that the process required no fewer than seven steps each needing a specialised circuit. Once he had thus analysed the problem, the circuit design presented little difficulty. Such models aided an understanding of the prototype, in this case the living brain—the title of Grey Walter's book.

Pointing to the size of the brain of the bee in relation to its functional capacity and the size and complexity of the system which man would have to produce if he was to imitate the brain of man, Mr. Meredith remarked that for the smallest cell one could hope to synthesise a housing capacity of several million cubic feet would be required.

A.S.E.E. Conference

MR. G. H. PARKER, Associate I.E.E., chairman of the Association of Supervising Electrical Engineers, presided at the Association's annual conference held at Blackpool last week-end. In his address Mr. Parker reviewed a number of current matters affecting the electrical industry (among others)—the rising cost of living, inflation, foreign competition, the European Common Market, Monopoly Commission inquiries, and the reduction in defence expenditure. Regarding the last item, Mr. Parker said that the electronics side of the electrical industry was dependent on defence expenditure for over half its output.

Between them, the Government, management and men must aim at maximum high-quality production, coupled with really efficient universal salesmanship, and this was a matter of the greatest urgency. There also had to be an entirely new conception of industrial relationships and philosophy of production by management and men.

The A.S.E.E. was proud of the achievements of the Electrical Engineers' Exhibition; the Association was playing its part in encouraging young people to enter the industry and the training and education feature of the Exhibition was supported by 28 bodies concerned in these matters.

INDUSTRIAL NEWS

Large Generators for Canada

The Metropolitan-Vickers Electrical Co., Ltd., has received an order for two 150 MW turbo-generator sets, complete with condensing, feed-water heating, and de-aerating plant, from the Montreal Engineering Co., Ltd. These machines are believed to be the largest ever purchased by any privately owned utility outside the U.S.A. The equipment covered by the contract, which is worth more than $5·5 million, will be manufactured at the M-V Co.'s Works at Trafford Park, Manchester, and Germiston, Glasgow. It will be installed at the Wabamun power station of Calgary Power, Ltd., where the first of two Metropolitan-Vickers sets of 66 MW capacity was recently commissioned.

The new generating sets, which run at 3,600 r.p.m., will have three-cylinder close-coupled tandem-compound turbines each designed for a maximum economic rating of 120 MW and a maximum capability rating of 150 MW. The turbines will take steam at 1,800 p.s.i.g. 1,000 deg F, and reheating to 1,000 deg F will take place between the high-pressure and intermediate-pressure cylinders. They will be direct coupled to a.c. generators rated at 166·66 MVA, 0·9 power factor, and 0·75 short circuit ratio; the generators will be hydrogen-cooled, using hydrogen at a pressure of 30 p.s.i.g. The condensers, which will be fitted with divided water boxes, will have a cooling surface of 73,000 sq ft each. Six-stage feed-water heating will be provided.

Illuminating Engineering Courses

After consultation with the Ministry of Education, the Benjamin Electric, Ltd., in conjunction with the principal of one of the technical colleges, has initiated one-day courses in illuminating engineering. These courses will be held from time to time during the year, and the first one took place recently at the Tottenham Works of the company when sixteen lecturers in electrical engineering from technical colleges in London and the Home Counties attended. Mr. Howard Long, of the Benjamin Electric, supervised this course, and a comprehensive programme was arranged which included lectures by Mr. J. S. Studholme, the company's chief technical engineer, and Mr. W. Imrie Smith, the chief lighting engineer. A tour of the two factories and the laboratory was included.

Electrical Aids to Gardening

The electricity stand at the Royal Horticultural Society Show at Chelsea, on 21st to 24th May, will emphasise the labour saving attributes of electrical equipment in the garden. The exhibit, organised by the Electrical Development Association, will show an amateur's greenhouse which will include thermostatically controlled tubular heating. A special feature will be the "covered bench" or "greenhouse within a greenhouse" across one end of the house. Low voltage soil warming will be used for two side borders in the house.

Supplementary lighting for irradiating tomato and cucumber seedlings will also be included. All wiring will be carried out in farm wiring cable.

New T.I. Nuclear Company

The formation of a new subsidiary company, T.I. Nuclear Engineering, Ltd., with head office at the Adelphi, London, W.C.2, is announced by Tube Investments, Ltd. (see "New Companies" section, page 937). Its purpose is to assist the T.I. operating companies which are concerned with activities in the atomic energy industry in the promotion of business at home and abroad.

The following are among the products being supplied by T.I. companies:—Components in reactor-grade materials, fuel element cans and sheaths, and applications of the rare metals for structural purposes; reactor components such as neutron starter tubes, burst slug detector gear components, control rods, control rod stand pipes, charging and discharging tubes, core restraints, absorber rods, fuel element supports and reactor tie bars; and steel tubes, heat exchanger components, stainless steel tubing, coils, pressure vessels, aluminium components, electrical switchgear, and rolling mills for nuclear metals.

The new company, in association with the Tube Investments Research Laboratories at Cambridge and its Technological Centre at Walsall, also offers outside organisations sponsored research and design work, and radiation facilities.

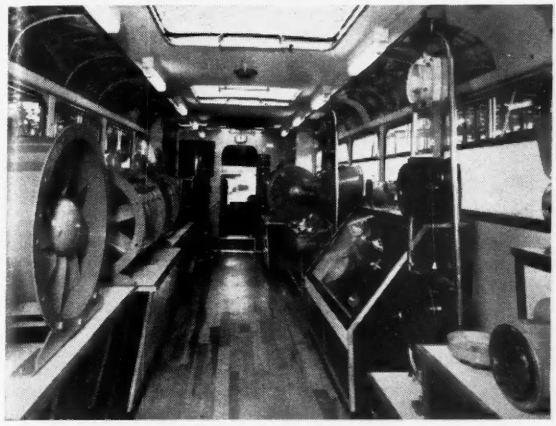
Diploma in Technology Courses

The following proposed new sandwich courses have been recognised by the National Council for Technological Awards as leading to the Diploma in Technology:—Northern Polytechnic: Physics and technology of electronics. Borough Polytechnic: Electrical engineering.

European Sales Drive for British Fans

A new mobile exhibition of British-made fans has begun a 9,000-mile long sales-development tour of Europe and Scandinavia. Specially built for the job, a coach-style vehicle has been fitted out by Woods of Colchester, Ltd., a subsidiary of the G.E.C., with examples of all types of the company's products. These range from miniature fans 2·4in in diameter, for cooling electrical equipment in aircraft, to machines for mines, ships and factories. Included are "Xpelair" window fans, roof ventilators, fan motors and a wide assortment of component parts. Facilities exist for working demonstrations of most of the fans. Mr. H. Woods is in charge of the travelling showroom. The tour will cover ten countries and last seven

Lecturers in electrical engineering at technical colleges in London and the Home Counties who attended a one-day course in illuminating engineering, at the works of the Benjamin Electric, Ltd.



Interior of the Woods of Colchester, Ltd., mobile showroom which is touring Europe

months. Woods European agents are providing staff to accompany the exhibition as it travels through each area.

Kent Coast Railway Electrification

The contracts recently announced by the Southern Region of British Railways in connection with electrification extensions to the East Kent coast include orders placed with the General Electric Co., Ltd., totalling over £1½ million for converting plant, switchgear and remote supervisory control. These cover mercury-arc rectifier equipments and metalclad switchgear for a total of 32 substations, together with the associated substation cabling and d.c. busbars.

The rectifiers will be of the pumpless, steel-tank type and will be similar in design to G.E.C. equipments totalling some 190 MW already in service on electrified lines in the Greater London area. In this instance 34 four-cylinder equipments with a combined rating of 85 MW are to be supplied, together with 111 units of metalclad switchgear with a breaking capacity of 750 MVA at 33 kV.

Supervisory control and indication equipment for the first two phases in this stage of the electrification will be provided at 63 substations and 65 track paralleling huts. Control will be effected from two control centres, one at Canterbury and the other at Paddock Wood.

Electrostatic Reproduction System

A dry electrostatic method of reproducing printed matter, etc., known as "Xerography" and developed in the United States, was demonstrated in London last week. No negative, photo-sensitised materials, chemicals or dark-room facilities are required. A copy of an original can be directly transferred to an offset master from which thousands of copies can be run off on an offset type of office duplicator. Printed matter, typewritten copy, detailed drawings or tabulated forms can be transferred at the same size, enlarged or reduced sizes on to a master original within three minutes.

After a "Xerograph" plate has been given a positive electrical charge it is exposed to light in a camera where the image affects the charged plate coating and where the plate is exposed to light the charge leaks away, leaving the unexposed areas capable of attracting a negatively charged powder. The powder image is transferred by a simple electrical operation to a positively charged sheet of paper which when heated fuses the powdered image form into a permanent print to be used as the master plate for duplication purposes.

The normal equipment consists of a "Xerox" camera, either model SS for same-size work or model VR for variable enlargement or reducing work, a processing unit, and a heat fuser unit.

The equipment is being demonstrated and marketed in this country by Rank Xerox Ltd., St. Andrews House, 33, Mortimer Street, London, W.1.

100 MW Turbo-Generators for Ferrybridge

Three 100 MW turbo-generator sets are being manufactured by C. A. Parsons & Co., Ltd., Newcastle-upon-Tyne, for the Central Electricity Authority, Yorkshire Division, to be installed in Ferrybridge power station. The first of these machines is now under course of erection at Ferrybridge, after having satisfactorily undergone a series of routine tests at Heaton Works. The accompanying picture shows the inner casing, core and windings of the generator for this first set being prepared for transport by rail to Ferrybridge, the outer casing having already been transported to site. The generators for these units have been constructed in two parts to facilitate both transport and lifting problems. The weight of the core and windings during transport is 135 tons, while the weight of the completed generator is approximately 200 tons. The turbines for these machines are of the three cylinder design and operate with steam conditions at the stop valve of 1,500 lb/sq in and 975 deg F with reheating to 950 deg F. The generators are rated at 100 MW, 0·8 p.f., and will generate at 13·8 kV, 50 c/s running at 3,000 r.p.m. They will be hydrogen cooled.

Air-conditioning in a Capsule Factory

A new factory at Slough (Bucks), capable of producing an average quantity of 10 million various kinds of gelatin capsules and a maximum of 15 million of smaller capsules daily, was opened by Mr. Kenneth Horne on 30th April on behalf of R. P. Scherer, Ltd.

A noteworthy feature of the plant is the air-conditioning system capable of handling 96,000 cu ft of air per minute. After going through an electrostatic filter air is passed through four "Humiditrol" liquid desiccant air drying units and transferred by two-stage axial-flow fans at the rate of 5,000 c.f.m. to whatever part of the process it is designed for. The air going to the cooling system enters an air stream of 18,000 c.f.m. which is drawn through direct expansion refrigerator coils which chill it to the temperature required for gelatin cooling, the remainder going into another circuit of 18,000 c.f.m. which supplies the tumbler dryers adjacent to the capsulation machines.

In each of these two cases the balance of the air circulated is air

Part of a 100 MW turbo-generator leaving the works of C. A. Parsons & Co., Ltd., for Ferrybridge power station

drawn back from the Production Departments through "fibreglass" air filters. The air cooling is carried out by four refrigeration units, each set of which services one coil in the air cooling system. A fifth compressor set is installed as a standby unit.

The plant in the main air conditioner room includes 48 motors, totalling about 200 h.p. These and other secondary electrical circuits are controlled by a G.E.C. cubicle-type starter board which accommodates the stator-rotor starters for the 15 h.p. G.E.C. slip-ring motors on the main refrigeration compressor sets, and the direct-to-line starters for the remaining squirrel cage motors which vary between 1 and 7½ h.p. Each plant is controlled by a single push-button and the individual motors in any unit are started in accordance with a predetermined sequence.

Contract for Iraqi Project

A *Reuter* report from Baghdad states that Balfour Beatty & Co., Ltd., have been awarded a £1,181,689 contract by the Iraqi Development Board for the supply of steel towers and erection of all the steel lines in the Northern Iraq electricity system.

Boiler Feed Pumps

An order for boiler feed pump sets for Bradwell nuclear power station has been placed with the Harland Engineering Co., Ltd., by C. A. Parsons & Co., Ltd., on behalf of the Nuclear Power Plant Co. Bradwell power station is being built in Essex for the Central Electricity Authority and Harland's contract covers six high pressure and four low pressure boiler feed pumps with motors.

Works Visit

Sir Hamish D. MacLaren, Director of Electrical Engineering, Admiralty, accompanied by Mr. W. C. M. Couch, Deputy Director, and Mr. A. S. Berry, regional electrical engineer, Midland Region and Wales, recently visited the works at Bushbury, Wolverhampton, of the Electric Construction Co., Ltd., and were particularly interested in Admiralty type a.c. switchgear now in course of manufacture for H.M. ships. The accompanying picture was taken during the visit.

New Irish Company

A wide range of electrical products, including h.v. transformers, are to be manufactured by a new company, Unidare Engineering, Ltd., at Portadown, Co. Armagh, Northern Ireland. The Northern Ireland Development Council announces that pending the erection of a Government-built factory of 20,000 sq ft production will commence by the end of June in a pilot plant obtained with the assistance of the Portadown New Industries Development Council. In addition to electrical products, stranded steel stay wire and barbed wire will be manufactured. Unidare Engineering is closely associated with the Pye Group, and Mr. C. O. Stanley, chairman of Pye, Ltd., will be chairman of the new company. Mr. A. R. Bradshaw will be managing director; he is also managing director of Bessbrook Products, Ltd., and the Aberdare Electric Co., Dublin, and is a director of Corran Works, Pye, Ltd., and other companies. Mr. P. H. Greer, general manager and a director, holds similar positions in Bessbrook Products and is also managing director of Pye Telecommunications, Ltd.

Trade Announcements

Mr. H. V. Richards has been appointed representative of **Ekco-Ensign Electric, Ltd.**, covering part of the Middlesex area and some western postal districts. Mr. P. Murrell will cover the West End of London area.

Under an agreement concluded between LogEtronics Inc., of Alexandria, Virginia, U.S.A., and **E.M.I. Electronics, Ltd.**, of Hayes, Middlesex, the latter company has secured the rights to manufacture under licence in this country automatic photo printer and exposure control equipment and to sell it throughout the British Commonwealth and other countries. The agreement also provides for joint participation in and integration of future development work for this and kindred devices in the photographic and other fields.

Switchgear & Equipment, Ltd., have recently established an arrangement by which Galbraith & Grant, Ltd., 30, Throgmorton Street, London, E.C.2, will handle all the company's export inquiries.

The **Simplex Electric Co., Ltd.**, announces that arrangements have been made with Noyes (Australia) Proprietary, Ltd., for the manufacture under licence in Australia of the Creda "Stargazer" electric cooker. Other Creda models will continue to be exported from England as previously.

"Ten shots a penny" is the message on a new display carton for "Atlas" No. 1 "Photoflood" lamps, issued by **Thorn Electrical Industries, Ltd.** Coloured in red, white and black, the carton holds 12 lamps each of which has a newly designed individual pack containing an instruction leaflet. New individual lamp packs have also been introduced for "Atlas" 75 W and 150 W opal glass high-intensity enlarging lamps.

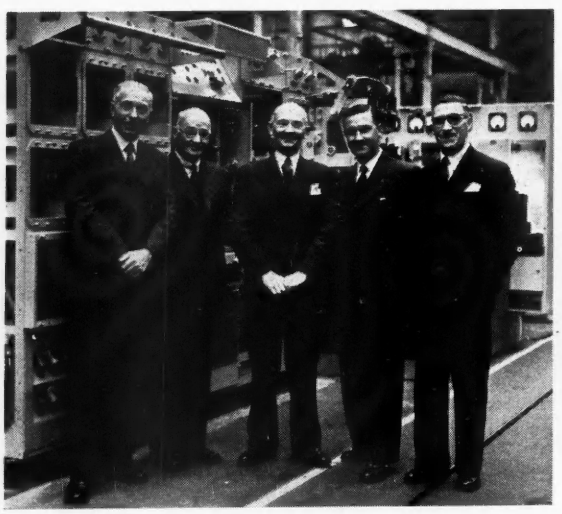
The London branch office of **George Ellison, Ltd.**, and their associate company, **Tufnol, Ltd.**, will be transferred on 20th May from Victoria Street to Ellison House, Connaught Place, London, W.2 (telephone: Ambassador 3121).

Mr. R. M. Gordon has been appointed area manager, **S.E.V. (Sales & Service), Ltd.**, for the counties of Somerset, Gloucester, Wiltshire, Dorset, Devon and Cornwall. His headquarters are at Bath (telephone: 5625). Mr. H. Armstrong becomes senior service engineer in the London and Southern area. He will operate from Bexleyheath (15, Longleigh Lane).

The electronics division of **Gresham Transformers, Ltd.**, is now established at Lion Works, Hanworth Trading Estate, Feltham, Middx. (telephone: Feltham 6661). This factory is devoted entirely to the design and manufacture of transformers for the electronics industry.

Motor Starters

In the *Electrical Review* of 19th April (page 733) the new range of motor starters with ratings up to 40 h.p. which are made by British Klockner Switchgear, Ltd., were wrongly described as having been made by Dorman & Smith. The company is a member of the Dorman & Smith Group but it trades entirely as a separate company. The company also points out that it exhibited a complete range of control apparatus for under-floor and thermal storage space heating systems.



Mr. W. C. M. Couch (Deputy Director of Electrical Engineering, Admiralty); Mr. J. M. Boyd (chief switchgear engineer, E.C.C.); Sir Hamish D. MacLaren (Director of Electrical Engineering, Admiralty); Mr. J. C. Milne (managing director, E.C.C.); and Mr. A. S. Berry (Admiralty regional electrical engineer, Midland Region and Wales), at the works of the Electric Construction Co., Ltd.

NEW ELECTRICAL EQUIPMENT

P.T.F.E. Equipment Wires

BRITISH INSULATED CALLENDER'S CABLES, LTD., 21, Bloomsbury Street, London, W.C.1, announce the introduction of a new range of equipment wires suitable for use at high temperatures in aircraft and electronic equipment. These wires are insulated with polytetrafluoroethylene (p.t.f.e.) and have been developed in close co-operation with the Ministry of Supply.

P.t.f.e. has mechanical, temperature and electrical properties ideally suited to these applications. It will operate at temperatures of up to 240 deg C and remains flexible down to very low temperatures. It is non-inflammable and is completely unaffected by oils, fuels and solvents. The material also possesses low permittivity and power factor, together with very high insulation resistance.

Type A is suitable for operation at voltages up to 350 V r.m.s., while Type B is designed for use at up to 500 V r.m.s., in both cases when incorporated in the wiring of equipment.

Low Torque Rotary Switch

A sealed sub-miniature and low torque rotary switch has now been added to the range of micro precision switches manufactured by HONEYWELL-BROWN, LTD., Wadsworth Road, Perivale, Middlesex. It contains a basic 11 SM3-T sub-miniature switch and is embedded with an epoxy resin in an aluminium casting treated to resist corrosion. The operating pin-plunger is of stainless steel and is bonded to the silicone rubber diaphragm which itself is bonded to the casing. Connecting leads are pre-soldered to the switch terminals before "potting."

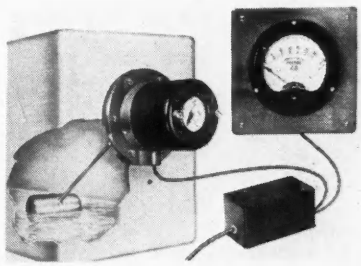
The switch is suitable for operation within the temperature range of −65 deg F to +180 deg F and is electrically rated at 30 V d.c. for 2·5 A inductive, and 4 A resistive, at 50,000ft altitude. For 250 V a.c. electrical rating is 5 A and inrush current is limited to 15 A. Contact action is single pole double throw. Switch leads are available in varying lengths and have nylon/glass type insulation.

Remote Reading Contents Gauge

The R. & G. Type "B" gauge manufactured by BAYHAM, LTD., 12, Lower Grosvenor Place, London, S.W.1, has now been followed by a companion instrument designed for use in explosive atmospheres where gases in the pentane and hydrogen classes may be present. The gauge consists of a tank unit, receiver, and a power unit which must be kept out of the danger area.

The tank unit utilises the R. & G. magnetic drive through the solid body of the unit, which ensures complete seal-off of the tank under pressure and vacuum conditions. The float arm initiates a rotary movement to the magnetic coupling which operates the electrical transmitting mechanism. Special types of tank units are available to suit high and low temperature application, inter-face operation and test pressures up to 560 p.s.i.g. The power unit converts single-phase a.c. mains supply into low voltage d.c. and incorporates an adjustable resistance in order that line losses may be compensated.

The receiver is a standard panel-mounting moving coil instrument and



Bayham R. & G. intrinsically safe remote reading contents gauge for use in hazardous areas

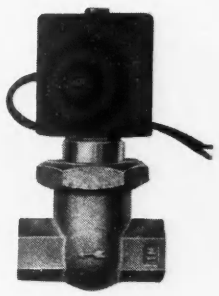
a special feature is an off-scale indication in the event of supply failure. This model has Ministry approval under Certificate No. I.S. 3010, Issues 1 and 2, and complies with British Standard Specification B.S. 1259 : 1945.

Solenoid Water Valve

The "Flomax" valve is a two-way normally closed solenoid type for water and is specially designed for maximum flow capacity. It is manufactured by BIRFIELD INDUSTRIES, LTD., Stratford House, Stratford Place, London, under licence from Hays Manufacturing Co., of Erie, Pennsylvania, U.S.A.

The valve is self-closing, quick acting, packless, anti-hammer and quiet in operation. Pilot operation permits maximum flow volume through a full port area and the valve is designed so that line pressure is permitted to do most of the work. The solenoid is required to lift only a small plunger.

The valve is readily adapted to direct switch operation, automatic or remote control, and also time cycle operation. All parts are incorrodible and the valve is suitable for pressures up to 150 lb/sq in.



Birfield Industries' two-way normally closed solenoid "Flowmax" water valve

Electric Cooker Colours

A wider range of colours for the "Britannia" electric cooker has been announced by the manufacturers, BRITISH NATIONAL ELECTRICS, LTD., Newarthill, Motherwell, Lanarkshire.

The latest colour is new ivory and the complete colour range for the cookers is now as follows:—New ivory —with ivory hob and cream handles; cream—with cream or black hob and red handles; and white—with black hob and red handles. Future models will also have a French grey plinth instead of the usual black finish.

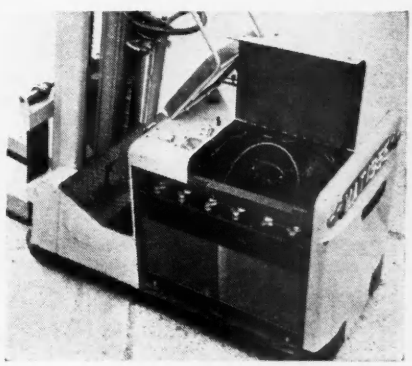
A further improvement in appearance has been made by fitting a chromium bezel between the oven door and handle.

Fork Lift Truck

A fork lift truck powered by a 24 V battery which operates a heavy duty constant speed reversing motor is now being manufactured by MATLING, LTD., 28, Caxton Street, Westminster, London, S.W.1. The new model, Type RFLT2, is rider controlled and has a maximum lifting capacity of 3,000 lb at a load centre of 20in.

Transmission to the single rear wheel is through a multi-plate clutch and a gear box providing three speeds. The advantage of this arrangement is that it dispenses with the use of complicated electrical control gear

Matling battery powered fork lift truck

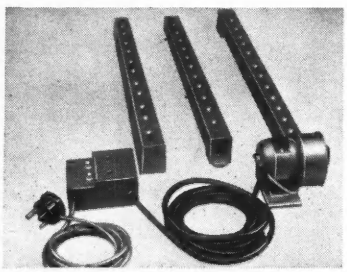


equipment. Lifting and tilting are effected hydraulically by means of a separate 24 V series wound motor direct coupled to a gear type pump which supplies pressure to the lifting and tilting jacks operating the telescopic mast assembly. The three gears are selected by means of a lever on the steering column. A green light on the facia panel shows when forward speeds are engaged and a red light indicates reverse motion. A device is also incorporated which prevents the operator from lifting a load of excessive weight.

Heights of lift ranging from 54in to 144in can be provided. The mast tilt is 2 deg forward and 10 deg backward. The cast steel lifting forks, which are laterally adjustable from 13in to 27in, are supplied in lengths to suit customers' requirements.

Shop Window De-Mister Unit

A small shop window de-mister unit suitable for installation in both curved and angled windows has now been developed by H.R. ELECTRIC MOTORS (NEWHAVEN), LTD., Bridge Works, Newhaven, Sussex. The unit comprises a small blower motor of the shaded pole type which fits into approximately a 4½in cube and this is attached to trunking of approximately 1¼in section in which is mounted a



H.R. Electric Motors shop window de-mister

heating element. The trunking can be supplied in units variable by 6in from a 2ft basic unit up to a total length of 6ft for each blower motor. The heater element is of 200 W capacity and the air displacement is of the order of 15 to 20 cu ft/min. The unit is supplied complete with a remote control switch console with neon indicator lights for both the motor and the heater. The heater cannot be switched on unless the motor is running.

The price of the 6ft unit is £11 16s 3d, with reduced prices for shorter units.

Wiring Accessories

In the new "Ruby Range" of electrical wiring accessories available from E.F. ELECTRIC, LTD., Willow Lane, Watford, Herts, the colour has been selected to blend with any scheme of decoration: whether contemporary or traditional.

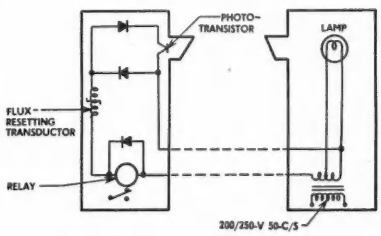
Included in the range are 3-pin plugs in 2, 5, 13 and 15 A sizes; flush, plaster depth 5 A switches; 13 A surface and flush shuttered sockets; and surface and flush switch sockets in 2, 5, 13 and 15 A sizes. Further particulars and prices may be obtained from the manufacturers.

Photo-Transistor Relay

The "Magistor" photo-transistor relay recently introduced by the METROPOLITAN-VICKERS ELECTRICAL CO., LTD., Trafford Park, Manchester, 17, is intended for use in place of mechanical limit switches in cases where it is not permissible to touch the initiator and where the speed of operation of a mechanical switch may lead to wear and failure. Typical applications are counting, level control, warning devices, material handling and smoke detection.

This new relay dispenses with the need for thermionic valves, large photo-electric cells and h.t. supplies, the total power consumption being only 16 W. The combination of a simple circuit and printed wiring enables the equipment to be offered at an attractive price.

The equipment consists of a lamp box and a receiver. The lamp box contains a transformer supplying a prefocused lamp, whose light passes through a lens to produce a parallel beam. This light is directed on to a



"Magistor" photo-transistor relay circuit schematic diagram

receiver unit where it is focused by a lens on to the photo-transistor. The output of the photo-transistor energises a flux-resetting transductor, which controls a relay having change-over contacts. The relay operates when the light beam is broken.

Air Dryers

A unit type air dryer which will maintain high operating efficiency at temperatures down to, and below, freezing point, has been developed by the LIGHTFOOT REFRIGERATION CO., LTD., Abbeydale Road, North Circular Road, Wembley, Middlesex. Applications include the protection of electrical and mechanical equipment in unheated buildings and for turning damp cellars into dry usable storage space.

The units are fitted with a simple auto-defrosting device and can be arranged for either automatic or hand control. They incorporate a ¼ h.p. hermetically sealed refrigerating system and are capable of removing up

Lightfoot air dryer for low ambient temperatures

to 30 pints of water per day, depending upon the relative humidity of the surroundings. The overall dimensions are 1ft 1½in by 1ft 10in by 1ft 4in high and the units are available for either 220/240 V 50 c/s or 110/120 V 60 c/s, single-phase supply. For higher ambient temperatures the machines can be supplied without defrosting, and a de luxe domestic model designed to prevent condensation forming in a normal size dwelling is now in production.

Level Controller

The "Aquatrol" level controller for conducting solutions has been developed by FIELDEN ELECTRONICS, LTD., Wythenshawe, Manchester. It provides simple, safe and sensitive alarm, indication and on/off control of electrically conducting liquids.

When probes, connected to the electronic unit, make or break contact with the liquid under observation the relay incorporated in the unit opens or closes as required. Relay contacts may be so connected as to operate visual or audible warning systems, as well as pump motors, or any other control function required by the particular application. The "fail-to-safety" arrangement ensures the complete protection of the system.

"Aquatrol" liquid level controller

GENERATION AND DEVELOPMENT

New Hunterston Inquiry

The Secretary of State for Scotland has announced that a further public inquiry into the Hunterston (Ayrshire) nuclear power project is to be held, following the death of Sir Randall Philip, Q.C., who conducted the first inquiry earlier this year and who was unable to complete his report. The new inquiry will be held under the chairmanship of Sheriff H. R. Leslie, Q.C., who will announce the date and place.

On 10th May Mr. Leslie called a meeting of the interested parties to discuss procedure in connection with the resumed inquiry. It was resolved that they should obviate the undue expenditure of time and money which a complete rehearing would involve. Instead, as suggested by Mr. Leslie, he will read the recorded notes of previous evidence. Mr. Leslie agreed it might be open to the parties, after giving due notice, to lead additional evidence. The next point to be decided would be whether the legal representatives of the various parties should again address the Commissioner or whether the speeches made before Sir Randall should be read.

The Dean of the Faculty of Advocates, Mr. C. W. Graham Guest, Q.C., representing Miss E. Hunter, who owns the Hunterston estate, and other objectors, said that as he had not taken part in the previous inquiry, he would reserve his right to supplement the speech which had been made by Mr. C. H. Johnston, advocate, who is now the Dean's junior in the case. Mr. A. Thomson, Q.C., for the promoters, said he agreed substantially, but added that if there were a prospect of fresh evidence being led for the objectors, he would wish to reserve his right in that matter.

Mr. Leslie said he hoped to make the next move in about three weeks' time, after he had read the evidence. He would also visit the proposed site for the station.

Liability for Change-Over

A complaint regarding the change-over of supply to premises from d.c. to a.c. was recently discussed by the Western District Committee of the London Electricity Consultative Council. Because there had been a change of ownership the new owner of the premises was required to make a lift suitable for a.c. operation at his own expense. It was decided to ask the Board to investigate the case and to indicate its general policy in dealing with consumers who bought properties having a d.c. supply which the Board wished to change to a.c.

At last week's meeting of the Consultative Council Mr. R. T. D. Wilmot said that when the matter was considered by the Western District Committee various arguments were put forward by the Board but the Committee was not satisfied that the policy was equitable and it was agreed to ask that the Board should reconsider its decision.

The secretary of the Board (Mr. S. Morton Gore) informed the Council that at its last meeting the Board had fully considered the question and had come to the conclusion that it could not alter this long-standing practice the legality of which had been clearly laid down in a High Court ruling.

After further discussion the Council decided to invite the chief commercial officer of the Board to explain the position to the Council.

Comparative Power Costs

Mr. A. A. Fulton, general manager of the North of Scotland Hydro-Electric Board, addressing the Dundee Rotary Club last week on "Hydro-Electric Power in the Nuclear Age," said that if atomic power alone were used to meet the varied electricity demand of the North of Scotland at the present time, the cost of production would be about 1·25d/kWh instead of the 0·64d/kWh which was what it cost the Board to produce its water power in 1956.

Despite the claim that by 1980 the production costs of base-load energy from nuclear power would have fallen to no more than 0·40d/kWh, the production cost of all the Board's requirements by nuclear power would then still be as much as 1d/kWh. Even if in the meantime costs of water power rose, there should still be in 1980 quite a margin between the Board's water power costs and this figure.

Uskmouth Extension

The Central Electricity Authority has received the consent of the Minister of Power to the extension of Uskmouth power station, Newport, Mon., by the construction on the same site of a second station to be known as Uskmouth "B." The new station will have a total installed capacity of 360 MW, comprising three 120 MW turbo-generator sets and three reheat boilers.

The Uskmouth "A" station has a total installed capacity of 240 MW.

Shoreham Harbour Enlargement

In the May issue of *Electricity* (journal of the Central Electricity Authority) it is reported that the modifications at Shoreham Harbour to admit larger ships are nearing completion. The works, costing more than £2¾ million, are necessary in order to supply the coal required for the Brighton power station, which is being increased in capacity to 520 MW. The enlarged harbour will be opened in the summer in time for the plant commissioning.

Some 900,000 tons of coal per annum will be required and with this in mind the C.E.A. decided to build five colliers to be employed regularly on the Brighton run. As they were all ready for full commercial duty before Shoreham Harbour was able to take them, they have been employed during 1956-57 on helping to coal Littlebrook "B" power station in the Thames Estuary. Four of the colliers, namely, the s.s. *James Rowan, Sir John Snell, Charles H. Merz* and *Sir William Walker*, are of 3,400 tons and one, the s.s. *Sir Johnstone Wright*, of 4,200 tons.

From loading points as scattered as the Tyne, Humber and the Continent, the ships carried 1,118,000 tons for a total cost of £504,000, i.e. 9s 0¼d per ton. By the most economical chartering the bill would have been £624,000, or 11s 2d per ton. Thus, every ton carried by the new ships saved the Authority over 2s against the equivalent charter rate, a saving in the year of £120,000. As soon as the Shoreham Harbour modifications are completed and the ships are diverted to the Brighton station, the savings in freight are likely to be about 6s per ton.

Fuel Oil in Power Stations

Statistics published by the Petroleum Information Bureau (29, New Bond Street, London, W.1) show that the consumption of fuel oil for steam raising for public electricity supply in 1956 was 347,955 tons—more than double the 1955 figure, 171,875 tons. It was still only about 4 per cent of the total fuel oil consumption. Gas, diesel and fuel oil used by stationary engines in power stations, however, declined from 64,904 tons in 1955 to 60,673 tons last year.

OVERSEAS

Volta River Scheme Finance

According to *The Times*, reports from Accra indicate that Dr. Nkrumah, the Prime Minister of Ghana, may be looking to the United States for financial aid for the Volta River hydro-electric scheme which has more than doubled in cost in the last five years; the figure is now put at about £300 million. The original intention was that the money would be found jointly by the Ghana Government, the United Kingdom Government and U.K. and Canadian aluminium producers.

Reuter reports that three Americans arrived in Accra three or four weeks ago to make a preliminary survey.

Malta Plant Extensions

In order to be able to cope with the increasing load the Maltese Government has decided to extend the existing generating plant, states the *Overseas Review* of Barclays Bank. The additional equipment will consist of two steam turbo-alternators.

Financial Section

STOCKS and SHARES

IN view of the pace at which prices had previously been rising, a pause for consolidation came not unexpectedly to Stock Exchange markets. Irregular shifts of ground in the gilt-edged market have had their effect upon the behaviour of industrial shares. For the latter, the flow of company results and reports continues to carry persistent reminders of the erosion of profit margins through rising costs and the keenness of competition. In the electrical markets, attention was paid to Mr. Lionel Fraser's reminder, in his annual report to Babcock & Wilcox shareholders, that contracts in the sphere of atomic energy are just as competitive as they are elsewhere.

Babcock & Wilcox Report

Turnover of Babcock & Wilcox in 1956 was much the same as in the previous year, and the chairman's review accompanying the full accounts confirms that the effect of rising costs upon profit margins was mainly responsible for the drop of £700,000 in net profits reported earlier. Looking ahead, he advises shareholders that matters are approaching the stage at which further reductions in overall costs will be difficult to achieve. Taking into account also the keenness of competition, and the time taken for capital invested in new projects to become remunerative, he says that better figures are not to be expected for the present. The £1 shares have been on the dull side at around 75s, which is some 7s 6d below their recent best; but the yield of 4 per cent from the 15 per cent dividend shows the willingness of investors to take the long view, for which there is firm encouragement in Mr. Fraser's statement.

Head Wrightson Dividend

The £1 shares of Head Wrightson, a partner with A. Reyrolle and C. A. Parsons in the Nuclear Power Plant Company, remained well supported at 132s 6d after the company's announcement of increases in both the earnings and the final dividend on account of 1956. The price has come up from 115s since the beginning of the year. The final 15 per cent payment makes a total of 22½ per cent, representing an increase of 2½ per cent on last year's, and the sixth successive improvement in the shareholders' annual return. It is comfortably accommodated by a 27 per cent expansion of the net profit to £623,000: about three-quarters of this remains to be ploughed back into the business after the dividend distributions.

Price Changes

Despite a pause in the general advance of prices, a number of electrical shares had climbed further, by the beginning of this week, to their best prices of the year. Among them were E. K. Cole, Marryat & Scott, S. Smith, Telegraph Condenser and Associated Automation. In the heavy engineering section,

Price Changes in

Company or Board	Nom. Value	Middle price 13th May	Week's Rise or Fall	Dividend Previous	Dividend Last	Yield %	1957 Highest	1957 Lowest
Gilt-edged Stocks						£ s d		
Brit. Elec. 1968/73	100	75⅛	−2	3	3	3 19 6	80	75
Brit. Elec. 1974/77	100	74½	−1	3	3	4 0 6	78¼	73½
Brit. Elec. 1976/79	100	78½	−1	3½	3½	4 9 3	81⅛	77¼
Brit. Elec. 1974/79	100	90½		4¼	4¼	4 14 0	92½	87¼
Overseas Electric Supply								
Calcutta Elec.	£1	19/-		6†	6†	6 6 3†	19/-	18/3
East African Power	£1	21/-		7	7	6 13 3	21/-	19/3
Nigerian Elec.	£1	17/6		10	10*	11 8 6	18/6	17/3
Perak Hydro-Elec.	£1	17/-		10	10*	11 15 3	17/-	13/3
Electrical Shares								
Aberdare Cables	5/-	12/6		17½	17½	7 0 0	12/6	9/9
Aerialite	1/-	6/-	+3d	45	48	8 0 0	6/-	4/9
Allen, W. H.	£1	44/6		20	10*	4 10 0	44/6	33/6
Anglo-Portuguese Tel.	£1	26/9	−9d	8	8	5 19 9	27/6	20/6
Aron Elec. Ord.	£1	56/3		15	15	5 6 9	56/3	53/6
Assd. Automation	10/-	24/9	+1/6	10	5	2 0 6	24/9	17/9
Assoc. Elec. Ord.	£1	68/9		15	15	4 7 3	73/-	62/6
Automatic Tel. & El.	£1	72/6	+5/-	15	17	4 13 9	72/6	54/6
Babcock & Wilcox	£1	75/-	−1/3	15	15	4 0 0	82/6	71/6
Bakelite	10/-	24/6		16	15	6 2 6	24/6	20/9
Baldwin, H. J.	2/-	4/3		20	20	9 8 3	5/-	4/-
Berry's Electric	5/-	6/3		—	10‡	8 0 0	6/3	5/6
British Aluminium	£1	70/-	−1/3	12	12	3 8 6	71/3	63/9
Brit. Elec. Traction: Def. Ord. "A"	5/-	22/3		22½	22½	5 1 3	22/3	17/-
B.I. Callender's	£1	52/9	−2/-	12½	12½	4 14 9	55/-	48/3
B.I. Callender's 6% Pref.	£1	21/-		6	6	5 14 3	21/9	20/6
British Tabulating	£1	56/3	+1/3	9	9	3 4 0	56/3	42/-
British Thermostat	5/-	27/-		20	25	4 12 6	27/6	25/9
British Vac. Cleaner	5/-	6/3		15	10	8 0 0	8/-	6/6
Brook Motors	10/-	33/9		25	25	7 8 3	33/9	30/-
Brush Group	5/-	8/-		10	Nil	—	8/-	4/6
Bulgin, A. F.	1/-	5/-		50	40*	8 0 0	5/6	4/6
Burco Dean	5/-	13/-		22½	20	7 13 9	13/-	8/9
Cable & Wireless: Ord.	5/-	11/6		10	10	4 7 0	12/-	9/6
4% Loan	100	92½		4	4	4 6 6	92½	89
Chloride El. Storage "A"	£1	67/6		17½	17½	5 3 9	68/3	58/-
Clarke Chapman	£1	170/-		22½	27½	3 4 9	8½	6½
Cole, E. K.	5/-	22/6	+9d	17½	17½	3 17 9	22/6	16/6
Cossor, A. C.	5/-	6/-	−6d	15	Nil	Nil	7/3	5/9
Crabtree	10/-	25/6		20	20	7 16 9	25/6	23/3
Crompton Parkinson Ord.	5/-	16/6		16	16	4 17 0	17/9	14/6
De La Rue	5/-	19/-	−3d	30	30	7 15 9	19/9	16/3
Decca "A"	4/-	28/9		43¾	43¾	6 1 9	32/3	27/-
Desoutter	5/-	33/6		30	32½	4 17 0	33/6	27/6
Dewhurst	2/-	7/-		30	16¼*	4 12 9	7/6	5/9
Dictograph Tel.	2/-	7/9	+3d	20	20	5 3 3	7/9	6/9
Dubilier Condenser	1/-	5/6		25	30	5 9 0	5/9	5/6
Duport	5/-	19/-	+6d	23	25	6 11 6	19/6	17/6
E.M.I.	10/-	31/3	−1/-	15	15	4 16 0	33/3	23/9
Electrical Components	5/-	7/6		25	25	8 6 9*	7/6	6/6
Elec. Construction	£1	26/3		8½	8½	6 9 6	26/3	21/9
Elliott Bros.	5/-	29/3		17½	20	3 8 6	29/3	26/3
Enfield Cable Ord.	£1	16/3	+1/-	Nil	Nil	Nil	21/6	13/-
English Electric	£1	58/9	−1/3	12½	14	4 15 3	60/-	47/6
English Electric 3¾% Pref.	£1	13/-		3¾	3¾	5 15 6	14/3	13/-
Ericsson Tel.	5/-	46/-	+6d	20†	22†	2 7 9†	46/-	33/3
Ever Ready	5/-	35/-		35	35	5 0 0	35/3	30/-
Falk Stadelmann	£1	39/3	+3d	17½	17½	8 18 3	39/3	35/-

The above quotations are based upon middle prices in the Stock Exchange Daily Official List.
* After scrip issue. † Free of income tax. ‡ Dividend indicated.

Simon-Carves moved up to 30s 9d, under the influence of the annual results reported earlier, and Richardsons Westgarth reached 20s. Tube Investments were also higher after the declaration of an increase in the interim dividend. With the annual results expected next month, Vactric became active and strong, up to 20s 6d. Brook Motors were firm at 33s 9d, with bargains recorded up to 35s, after the company's indication of substantially higher earnings in the first half of the current year. Among recent issues, English Electric new ordinary shares receded to 10s 3d premium.

Electrical Investments

Company or Board	Nom. Value	Middle price 13th May	Week's Rise or Fall	Dividend Previous	Dividend Last	Yield % £ s d	1957 Highest	1957 Lowest
Electrical Shares—continued								
G.E.C. Ord.	£1	58/9		12½	14	4 15 3	58/9	48/9
G.E.C. 6½% Pref.	£1	22/-		6½	6½	5 18 3	23/6	22/-
General Cables	5/-	12/9		30	30	11 15 3	13/6	11/6
Greenwood & Batley	£1	46/3		17½	17½	7 11 3	46/3	45/3
Hackbridge Holdings	5/-	21/9		25	30	6 18 0	21/9	19/9
Hackbridge & Hewittic	5/-	15/-		30	23*	7 13 3	16/-	13/6
Head Wrightson	£1	132/6		20	22½	3 8 0	132/6	112/6
Heatrae	2/-	4/3		15	15	7 1 3	4/3	4/-
Henley's	10/-	15/9		11½	11½	7 6 0	17/-	15/3
Holophane	5/-	24/6	+3d	30	30	6 2 6	26/3	17/-
Hoover	5/-	38/6	−1/-	50	50	6 9 9	39/6	24/9
I.C.I.	£1	44/9	−1/9	10	10	4 9 6	46/6	37/9
Intl. Combustion	5/-	30/-		20	22½	3 15 0	30/-	20/-
Johnson & Phillips	£1	30/9	+2/6	15	10	6 10 0	34/6	28/3
Lancashire Dynamo	£1	43/9		11	11	5 0 6	45/-	36/9
Laurence, Scott	5/-	19/9	+6d	15	15	—	19/9	13/9
Lister, R. A.	£1	31/3		9·3	10	6 8 0	31/3	26/9
London Elec. Wire	£1	52/6	−9d	12½	12½	4 15 3	53/9	43/-
Lucas, J.	£1	35/9	−6d	7½	7½	4 4 0	36/3	30/6
Marconi Marine	£1	33/9		10	10	5 18 6	33/9	31/-
Marryat & Scott	2/-	10/9	+9d	30	30	5 11 6	10/9	8/-
Mather & Platt	£1	61/3	+9d	15	15	4 18 0	61/3	51/3
Metal Industries	£1	25/6		9	Nil	—	26/3	20/3
Midland Elec. Mfg.	£1	48/9		12½	12½	5 2 6	48/9	45/-
Morphy-Richards	4/-	16/9	+3d	50	50	4 15 6*	16/9	11/9
Murex	£1	76/3	+1/9	20	20	5 5 0	76/3	65/-
Newman Ind.	2/-	2/9		10	10	7 5 6	2/9	2/1
Oldham & Son	1/-	2/6		20	17½*	7 0 0	2/6	2/3
Parnall (Yate)	5/-	8/6	−3d	12	12	7 1 3	8/9	5/9
Parsons, C. A.	£1	68/9	−1/3	10	10	—	71/3	50/6
Plessey	10/-	82/6	−2/3	27½	30	3 12 9	84/9	61/-
Pye "A" Deferred	5/-	18/3		12½	12½	3 8 6	18/3	15/9
Reyrolle	£1	103/9	−1/3	16½	17½	3 7 6	110/-	90/-
Rheostatic	4/-	10/-		18½	12½*	5 0 0	10/-	8/9
Richardsons Westgarth	5/-	20/-	+1/-	16½	16½	4 3 3	20/-	17/-
Scottish Cables	4/-	18/3		27½	27½	6 0 6	19/3	15/-
Simon-Carves	5/-	30/9	+9d	28½	20*	3 5 0	30/9	26/-
Smith (England), S.	4/-	15/3	+3d	17½	17½	4 11 9	15/3	13/-
Southern Areas	£1	18/9		10	7½	8 0 0	20/-	13/9
Strand Elec.	5/-	7/9		15	15	9 13 6	8/-	7/3
Sturtevant	5/-	25/9	+1/3	15†	15†	2 18 3†	27/-	24/3
Sun Elec.	£1	43/9		20	25	11 8 6	43/9	43/9
Switchgear & Cowans	5/-	15/-		25	25	8 6 9	15/6	13/6
Taylor Tunnicliff	5/-	13/3		15	15	5 13 3	13/9	11/9
T.C.C.	10/-	40/-	+1/3	25	25	6 5 0	40/-	35/-
T.C. & M.	£1	29/-	−9d	8½	8½	5 17 3	31/-	24/6
Telephone Mfg.	5/-	8/-		10	10*	6 5 0	8/-	6/3
Telephone Rentals	5/-	12/6		12½	12½	5 0 0	12/6	10/3
Thompson (John)	5/-	33/9	+6d	25	25*	3 14 0	37/-	29/3
Thorn Elec.	5/-	25/-	−1/3	15	15	3 0 0	26/3	16/3
Thornycroft	£1	36/6		15	12½	6 17 0	37/6	32/9
Tube Investments	£1	68/9	+1/9	22½	15*‡	4 7 3	68/9	58/3
Vactric	5/-	20/6	+1/9	15	17½*	4 5 3	20/6	12/9
Veritys	5/-	9/-		12½	12½	6 19 0	9/3	8/3
Walsall Conduits	4/-	14/6	+3d	70	20*	5 10 3	14/6	11/-
Ward & Goldstone	5/-	48/-	+1/-	30	35	3 13 0	48/9	36/9
Watford	2/-	6/9	+3d	25	25	7 8 3	6/9	6/3
Westinghouse	£1	40/-	−1/3	18	9‡	4 10 0	41/3	36/-
West, Allen	5/-	16/6	−3d	15	15	4 11 0	16/9	12/3
Wolf Electric	5/-	11/-	+6d	20	20	4 10 9*	11/-	8/9

Automatic Telephone

The £1 shares of Automatic Telephone & Electric came further into favour after the appearance of the full report. In rising 5s, to 72s 6d, they have given one of the best of recent performances in the electrical market. In his review, the chairman credits the half-million improvement in the group's 1956 trading profits (before tax) to a record output and to the higher earnings of subsidiaries at home and abroad. Referring to the addition of a 2 per cent bonus this time to the 15 per cent rate of dividend paid for the past six years, he draws attention to the fact that the gross dividends represent only about 4½ per cent on the capital and surplus of the group. With a full order book at the start of the year, the company is budgeting for fresh manufacturing records. In the accounts, the dividend payments are shown to involve the distribution of well under one-third of the net profit available.

J. & P. Prospects

A recovery of 2s 6d to 30s 9d in the price of Johnson & Phillips £1 shares, following publication of the annual report, showed the market to be impressed more by references in it to this year's prospects than by the setback recorded in the figures for the past year. In that period, the group trading profit was approximately halved, to £311,000. With a net surplus, after tax, of £34,000 the company is reducing the ordinary dividend to 10 per cent from 15 per cent, the rate paid previously without interruption since the war. Falling copper prices and the general effects of the credit squeeze contributed largely towards the decline in profits. With evidence of a more favourable experience in the first quarter of the year, the directors anticipate (with the usual reservations) a considerable improvement in the next results. On the new rate of dividend the yield becomes 6½ per cent.

Electric Construction Issue

The Electric Construction Company's new convertible unsecured loan stock, of which half a million has been offered to the company's stockholders at 99, stands at about 104½, and is still transferable free of stamp duty. The stock carries interest at 5¾ per cent, and is redeemable between 1972 and 1977. In addition, holders have the option to convert each £50 stock into 36 of the company's £1 ordinary shares, this right being exercisable in September of any of the three years 1958–60. At the above price for the stock, this gives holders an option on the ordinary shares at a price equivalent to about 29s. They have been quoted lately in the neighbourhood of 26s 3d. The company estimates that trading results for the year ended last March will show an improvement on 1955–56.

REPORTS and DIVIDENDS

The Automatic Telephone & Electric Co., Ltd.—The ever-increasing importance of research in maintaining Britain's lead in export markets is emphasised by Sir Thomas Eades (chairman) in his annual report to shareholders. Sir Thomas, in reporting record output and profits for 1956, stresses that there probably never has been a period when such highly technical progress was being made as at the present time. This is costly and to play their part they have to spend an increasing amount on their research establishments. The company therefore proposes to increase its reserve by £150,000, to £750,000, and is earmarking over £467,000 from profits for scientific development work.

At home the British Post Office is pursuing the same forward policy in research and improvements in the telephone service. Sir Thomas pays a tribute to the important part played by the Post Office in the development and laying of the first Atlantic telephone cable, and mentions that other developments are in progress with the British telephone manufacturers.

Turning to the export field, the chairman says that business with seventy countries was well maintained during the year, and included many large contracts for exchange and line transmission equipment. But he adds a warning that the ability of British exporters to quote competitive prices in highly competitive markets depends on their ability to control costs of production.

Johnson & Phillips, Ltd.—The accounts for 1956 show a trading profit of £310,607, as compared with £647,588 for 1955, to which is added income from trade investments, transfer fees and a sum of £24,000 transferred from revenue reserve towards abnormal expenditure on reconstruction of buildings, etc., making £364,434. After meeting all charges, including £62,000 for taxation, the net balance is £33,510 (against £271,521). To this is added £147,821 brought in and £55,000 transferred from dividend equalisation reserve, making £236,331 available. It is proposed to pay a final ordinary dividend of 5 per cent (against 7½ per cent), making 10 per cent for the year (against 15 per cent). The balance carried forward is £108,124.

The accounts of the Scottish group show a trading profit of £19,533 (against £10,561).

The directors, in their statement, record that trading conditions during the year under review were considerably more difficult than during the previous year. There are a number of reasons for the reduced profit. The continuing reduction in the price of copper involved sales of some of their products in a falling price market and thereby caused unavoidable and substantial losses. There was a considerable reduction in the demand for cables by the nationalised industries and other buyers, due largely to the credit squeeze, and a general curtailment in capital expenditure. There was also a sharp fall in the level of export business, and both at home and abroad prices and profit margins were much lower than they had been in the past. This was particularly noticeable in the cable business. Another contributory factor was a loss suffered by the Australian factory, which manufactures switchgear and kindred products, but they believe that during the present year this factory will earn profits. The merchandising side of the Australian business has been satisfactory, and has produced useful profits. The Scottish factory, which mainly produces domestic electrical goods, has faced a serious curtailment of demand, due largely to restrictions in hire purchase facilities as another result of the credit squeeze. In the export market competition by other countries continues to be severe.

Results for the first quarter of 1957 are more encouraging; they have a better order book and copper prices appear to have an air of stability. It is expected that a considerable cable programme will follow the C.E.A. expenditure on new power stations. Progress in transferring the Switchgear and Capacitor Departments to the new Elizabeth Works at New Cross has proceeded satisfactorily and the workshops are rapidly coming into full production. The South African factory is now earning profits and general trading in that country continues at a satisfactory level, although profit margins leave, as yet, something to be desired. Their latest overseas enterprise is the incorporation in Canada of Johnson & Phillips (Canadian Sales), Ltd.

Referring to the development of submarine cable laying equipment, the statement says that when submarine telephone cables incorporating rigid type repeaters were originally being evolved, the company began, in collaboration with the G.P.O. and the Telegraph Construction & Maintenance Co., Ltd., to develop and manufacture special equipment necessary for laying these cables. Mr. A. C. Hartley, and their consultant, Mr. R. J. Ashby, have produced a design which promises well and a prototype is now being built in their workshops.

Babcock & Wilcox, Ltd.—The annual meeting will be held on 30th May. In his review of the year circulated to stockholders, Mr. W. L. Fraser says that the actual turnover was substantially the same as the record figure of 1955, but increased costs of production due to wage advances and higher prices of raw materials have further eroded the profit margin. The volume of work is still encouraging. During 1956 almost 40 per cent of the orders received were for the export market, a substantial proportion being in respect of contracts secured in the Commonwealth. The year was a record one for the receipt of new orders for marine boilers.

Mr. Fraser says that they have felt the stringency of the steel supply situation, and have suffered some curtailment of their production effort occasioned by the lengthening delivery periods of materials.

The Atomic Energy Department has been enlarged to enable them to handle the wide range of inquiries in this new development. Their main activity, in association with their partners, the English Electric Co., Ltd., and Taylor Woodrow, Ltd., is centred on the national programme for atomic power stations using graphite moderated reactors. A substantial percentage of their research and development work is devoted to studies connected with the problems arising from the raising of steam from an atomic reactor. In spite of the massive programme of power supply within the United Kingdom, it is hoped that adequate facilities will be available, both in money and materials, for maintaining this country's overseas business, not only for conventional power stations, but also for atomic energy stations. Markets once lost are difficult to regain and it is clear that British manufacturers need all possible encouragement at home in respect of long-term credits and credit insurance for this all-important export.

Referring to European economic co-operation, Mr. Fraser says that their company has for many years closely co-operated in engineering design, production techniques and otherwise with the Babcock organisations in Europe and with their European licensees. As the changes contemplated must of necessity be gradual, they do not anticipate any important reaction on their business.

To facilitate training within the works, they are building an education centre at Renfrew, which incorporates workshops, administrative offices and a lecture hall.

Mr. Fraser concludes by reviewing the progress during the year of the home and overseas subsidiary companies.

Lancashire Dynamo Holdings, Ltd.—The main figures in the accounts for 1956 were given in our issue of 19th April. In his circulated review of the year, Mr. S. F. Steward (chairman and managing director) says that the period was again one of progress in both orders and sales generally throughout the group and total orders in hand at the end of the year were higher than ever before. Although profits reached a record level, the ratio of profits to turnover is falling and it is clear that it will not be easy to maintain the present margin of profit at a time of rising costs and in more competitive

conditions. Each company in the group has made its contribution. Lancashire Dynamo & Crypto, Ltd., has achieved an all-time record of output and profit. The Trafford Park works in particular, where the larger machines are made, has been filled to capacity and has a very full order book. Output and profit of Foster Transformers, Ltd., were a record as were also the orders in hand. The year for Lancashire Dynamo Electronic Products, Ltd., was marked by an upward trend in orders and profits, and the company has more than doubled its production every two years; many new developments have been introduced.

Lancashire Dynamo Nevelin, Ltd., which incorporates the activities previously carried on by the Nevelin Electric Co., Ltd., and Lancashire Dynamo Switchgear, Ltd., has now completed its first year of operation, and in spite of the dislocation arising from the transfer of production from the old works at Croydon to the new works at Oxted, the total volume of output was increased and a satisfactory profit made. New developments in rectifiers are being introduced and attention is now being given to the redesign and extension of the range of switchgear to cater for modern industrial requirements. Output and profit of Crypton Equipment, Ltd., have been maintained, and in spite of the effects of credit restrictions and hire-purchase regulations on its range of products, Crypto, Ltd., has also maintained its turnover and profit. Dynamo & Motor Repairs has become a fully owned subsidiary of the group and here again orders and profits have been well maintained. Orders received by Malcolm & Allan (London), Ltd., electrical installation contractors, have been satisfactory.

The group's export business is expanding and the main markets have been and still are in the Commonwealth. They are represented in South Africa by Lancashire Dynamo South Africa (Pty.), Ltd., and in Central Africa by the newly formed company, Lancashire Dynamo Central Africa (Pvt.), Ltd. In South Africa they operated, in equal partnership with Crompton Parkinson, Ltd., a small motor factory. This enterprise was uneconomic; it has, therefore, been closed down and negotiations for the sale of the factory are proceeding. Consequently they are concentrating on the export of machines from the factories in this country. In Australia they have an equal partnership with their agents in Lancashire Dynamo Coates Pty., Ltd. In all these territories trading conditions have become more difficult with local manufacture a growing factor. Referring to the acquisition of J. G. Statter & Co., Ltd., Mr. Steward says that the benefit of this will not appear until next year's accounts.

Parnall (Yate), Ltd.—In the course of his annual review, the Earl of Limerick (chairman) says that in view of the fact that the Government increased the restrictions on hire-purchase trading in February, 1956, the directors consider that the profits for the year have decreased rather less than they feared would be the case at the beginning of last year. The trade in domestic electrical appliances for the year, although reduced compared with the previous year, has been such that they have maintained their share of the total business available. The current year has begun better than did 1956. The new clothes drying machine first introduced in January last has been well received by distributors and the public, with the result that not only are the sales of it much higher than they anticipated in the early months following its introduction, but at the moment they are not able to give prompt deliveries on incoming orders.

F. Perkins, Ltd.—The annual meeting was held on Monday last. In his statement which was circulated with the report and accounts for 1956, Mr. F. A. Perkins (chairman and managing director) said that the turnover for the year was £21·5 million, an increase of 8 per cent on the preceding year. They were able only to pass on to customers a part of the increased costs, however, and the net profit for the year, therefore, at £768,934, showed a decrease on 1955. There had been an overall increase in the number of engines exported, to a figure of 74 per cent of production, as direct exports and also indirect. The progress of the Canadian subsidiary continued, in Australia new marketing arrangements had been developed which had enabled them to meet the growing demand for engines there, in South Africa the favourable trend reported last year continued, and in India, Simpson & Co., Ltd., had made great strides in developing the manufacture of Perkin engines.

Taylor Woodrow, Ltd.—In his review of the past year, Mr. F. Taylor (chairman) points out that two major contracts awarded in respect of the High Marnham and Northfleet power stations brought to a total of fourteen the number of power stations upon which the company has been engaged in recent years. He says that the company is proud of the fact that it built the structure at Calder Hall and mentions that progress on the second station there is well ahead of schedule. Together with the English Electric Co., Ltd., and Babcock & Wilcox, Ltd., the company is actively engaged in the field for the supply of complete atomic power stations.

The Southern Areas Electric Corporation, Ltd.—The preliminary statement for 1956 shows consolidated profits of £82,390, as compared with £79,674 for 1955, after depreciation of £60,585 and amounts written off patent rights and development £11,233. Taxation absorbs £46,838, and after adding surplus taxation for preceding years of £9,378, the net profit is £44,930 (against £43,412), of which £40,158 is dealt with in the accounts of the holding company. The dividend for the year is unchanged at 7½ per cent, and £284,751 is carried forward (against £275,297 brought in).

E. K. Cole, Ltd., have created £1,000,000 of 5¾ per cent unsecured loan stock, 1977-82, and are to repay the existing £400,000 of 5 per cent unsecured loan stock, 1956-60, on 6th August next. Holders of the existing stock are invited to convert into the new loan stock and the balance of that stock not required for conversion is being placed privately at £98 per cent.

Turner & Newall, Ltd., propose to double the ordinary capital by a scrip issue, under which ordinary stockholders will receive one new ordinary stock unit of £1 for each unit held. The consent of the Capital Issues Committee has been obtained to the issue.

The City Electrical Co. (C.E.C., Ltd.) announces that contracts have now been exchanged and the company has joined the Norcros group. There will be no change in the directors, management or trading policy of the City Electrical Co.

The Westinghouse Brake & Signal Co., Ltd., announces that approximately 98½ per cent of the shares provisionally allotted in the recent rights issue were taken up. Over 800,000 excess shares were applied for and allotments had to be drastically scaled down.

Tube Investments, Ltd., has announced an interim dividend of 7½ per cent (against 6¼ per cent).

Holophane, Ltd., is maintaining its interim dividend at 7½ per cent.

Bowthorpe Holdings, Ltd., has received the consent of the Capital Issues Committee to a one-for-one scrip issue.

Radio Rentals, Ltd., has declared an interim dividend of 7½ per cent (against 10 per cent) on doubled capital.

Brook Motors, Ltd., are again paying a 5 per cent interim dividend but on capital increased by a one-for-four "rights" issue.

New Companies

T.I. Nuclear Engineering, Ltd.—Registered 1st May. Capital £100. So long as Tube Investments, Ltd., holds three-quarters or more of the issued shares it shall be sole director and manager. Solicitors: Allen & Overy, 3, Finch Lane, E.C.3.

Williams and Ford, Ltd.—Registered 17th April. Capital £5,000. To acquire the business of electrical engineers, contractors and dealers formerly carried on by the late Wilfred Williams at Cirencester and Northleach, Glos. Directors: Gladys M. Williams, M. E. C. Pitt and D. E. Brisland. Solicitors: Sewell, Rawlins & Logie, Cirencester.

Acton Wire Co., Ltd.—Registered 11th April. Capital £1,000. Manufacturers of and dealers in wires and cables and metals of all kinds, and in telephonic, telegraphic, radio and

electrical apparatus of all kinds, etc. Directors: A. D. Bates and Margaret B. Bates. Regd. office: 63-4, New Broad Street, London, E.C.2.

L.E.S. Distributors (Southend), Ltd.—Registered 25th April. Capital £1,000. Manufacturers of and dealers in electrical equipment, etc. Regd. office: 15-16, Alfred Place, Tottenham Court Road, W.1.

Londex Components, Ltd.—Registered 17th April. Capital £1,000. Manufacturers of and dealers in electrical goods of all kinds, etc. Directors: E. A. Loeb, W. Stern and A. Ney, all directors of Londex, Ltd. Regd. office: 13, Bloomsbury Square, W.C.1.

A. E. Cleverly, Ltd.—Registered 30th April. Capital £10,000. Electrical engineers, general electrical installation contractors, radio and television engineers, etc. Directors: A. E. R. Cleverly and Mrs. Minnie E. Cleverly. Regd. office. 15, Replingham Road, S.W.18.

Janet Engineering Co., Ltd.—Registered 26th April. Capital £100. Electrical engineers, etc. Regd. office: 156, Strand, W.C.2.

Bankruptcies

G. B. Solomon, 57, Fore Street, St. Columb, Cornwall, trading as St. Columb Radio, radio and electrical dealer.—Public examination 14th June at the Town Hall, Truro.

J. H. Pickwell, trading as J. H. Pickwell & Co., retailer of electrical goods and handicraft materials, at 79, London Road, East Grinstead, Sussex, and as an electrical engineer and contractor at 108, London Road, East Grinstead.—Last day for receiving proofs for dividend 21st May. Trustee, Mr. J. S. Bradley-Hole, 7, Old Steine, Brighton, 1.

J. F. Creasey, 5, Eccleston Crescent, Chadwell Heath, Romford, Essex, electrical installation engineer, formerly carrying on business under the name of Creasey Electrical Co., at 2, Regent Square, London, W.C.1, and 3, Fanshawe Avenue, Barking.—First and final dividend of 4s 3¼d in the £, payable on and after 4th June at 58-61, York Terrace, Regent's Park, London, N.W.1.

TRADE MARKS

APPLICATIONS have been made for the registration of the following trade marks. Objections may be entered up to 24th May:—

CON-ELECTRON. No. 759,830. Class 7. Miniature electric motors (not for land vehicles) and speed governors therefor.—Consolidated Electronics Industries Corp., New York, U.S.A. Address for service, c/o Cruikshank & Fairweather, 29, Southampton Buildings, Chancery Lane, London, W.C.2.

LANDMARK. No. 759,241. Class 9. Measuring apparatus and instruments (not being apparatus and instruments for measuring land) and apparatus responsive to change in physical, electrical and chemical conditions for automatically controlling such conditions; and parts.—Land Pyrometers, Ltd., Colonial Works, Queen's Road, Sheffield.

ELCHIM. No. 760,217. Class 9. Vacuum cleaners (electric) and parts.—Selchim S.R.L., Milan, Italy. Address for service, c/o A. A. Thornton & Co., Napier House, 24-27, High Holborn, London, W.C.1.

DECCAFAX. No. 761,033. Class 9. Scientific, nautical, surveying, navigating, optical, radio, radar, television, signalling, teaching and measuring apparatus and instruments; electrical and electronic apparatus and instruments; and insulated electric cables.—Decca Record Co., Ltd., 1 & 3, Brixton Road, London, S.W.9.

WELDPAK. No. 762,375. Class 9. Electrical capacitors (condensers).—Dubilier Condenser Co. (1925), Ltd., Ducon Works, Victoria Road, North Acton, London, W.3.

GRILLOFRANK. No. B758,968. Class 11. Electrically heated grilling apparatus for use on counters and on tables, and parts.—Ander-Masters, Ltd., 52, St. John Street, London, E.C.1.

LINOGLOW. No. 761,900. Class 11. Lighting fittings.—Linolite, Ltd.. The Mill Works, Malmesbury, Wiltshire.

STREET LIGHTING PLANS

The surveyor to **Gosforth (Northumberland)** U.D.C. has reported that the cost of converting the town's street lighting from gas to electricity would be over £50,000, but running costs would be only £4,713 per annum for electricity, against £6,300 for gas. It is expected that the Council will carry out the change-over in stages, over a number of years.

Hexham (Northumberland) U.D.C. is to spend £2,600 on lighting of the Newcastle-Hexham Road. Mercury lamps are to be used.

Lanarkshire County Council is to seek Ministry approval of a scheme, estimated to cost £22,110, for the conversion of the street lighting in Lanark from gas to electricity.

Lancaster City Council has approved a scheme costing £7,500 for the conversion of street lighting from gas to electricity.

Maidenhead Corporation is to invite tenders for the installation of fluorescent street lighting in Ray Mead Road and for tungsten street lighting in various other roads. The estimated cost is £6,000.

A £23,000 street lighting programme for 1957-58 has been approved by **Perth** Town Council, subject to loan sanction.

Poplar Borough Council is recommended to apply for sanction to borrow £9,000 for improved street lighting in East India Dock Road.

Sheringham (Norfolk) U.D.C. is to seek Ministry approval to the carrying out of a scheme, estimated to cost £3,625, for the supply and erection of 45 sodium street lamps in Cromer Road.

Southampton Corporation is to seek the Ministry's approval of schemes, estimated to cost £16,438, for improved lighting of traffic routes.

Sunderland Town Council is recommended to approve an estimate amounting to £6,745 for the provision of street lighting on the Hylton Red House estate.

During the next five years **Tynemouth** Town Council is expected to spend £30,000 on converting the street lighting from gas to electricity.

Westminster Works and Traffic Committee recommends a scheme for lighting the roads in Section 111 of Churchill Gardens at an estimated initial cost of £4,175.

Whitley Bay Buildings and Roads Committee has approved in principle a £63,000 scheme for converting all the town's street lighting from gas to electricity. It is recommended that the work shall be spread over ten years. It will involve converting 485 main road lamps and 1,369 side street lamps. About £5,000 per annum will be saved on maintenance and running costs.

Woolwich Borough Council is recommended to approve a scheme, estimated to cost £12,311, for the modernisation of side street lighting in 15 roads.

Yeovil Corporation is recommended to approve a scheme, estimated to cost £15,936, for the conversion of street lighting from gas to electricity.

NEXT WEEK'S EVENTS

Organisers of electrical functions are advised to make use of the "Electrical Review" clearing house, Room 221, Dorset House, Stamford Street, London, S.E.1, to ascertain that proposed dates do not clash with others already arranged.

Monday, 20th May

IPSWICH.—Electric House, 7.15 p.m. Ipswich and District Electrical Association. Annual general meeting.

LONDON.—Institution of Civil Engineers, Great George Street, Westminster, S.W.1, 5.30 p.m. Joint meeting of the Institutions of Electrical, Civil and Mechanical Engineers. Discussion on the Report on the Development of Hydro-Electric Power in the Soviet Union.

Savoy Place, W.C.2, 6.30 p.m. I.E.E. London Graduate and Student Section. Annual meeting, followed by film show.

Northampton Polytechnic, St. John Street, E.C.1, 6.15 p.m. Institute of Metal Finishing, London Branch. "The Use of Radio-Isotopes in Metal Finishing Research," by Dr. R. W. Cahn.

Wednesday, 22nd May

ENFIELD.—A.S.E.E. Oxford, Reading and Districts Branch. Visit to Atlas Lamp Works and Laboratories.

LONDON.—Savoy Place, W.C.2, 5.30 p.m. I.E.E. Supply Section. "Voltage Performance of Series Capacitors in Transmission and Distribution Lines," by J. M. Magowan. (To be read by L. L. Langton.)

Wednesday, 22nd May, to Saturday, 1st June

GLASGOW.—Kelvin Hall. Scottish Radio and Television Exhibition. 11 a.m. to 10 p.m. daily except Sundays.

Thursday, 23rd May

LONDON.—Savoy Place, W.C.2, 5.30 p.m. Institution of Electrical Engineers. Annual general meeting followed at 6.30 p.m. by "General Applications of Digital Computers," by Dr. A. D. Booth.

MAIDSTONE.—Royal Star Hotel, 7.30 p.m. A.S.E.E. Kent Branch. Annual general meeting.

SOUTHAMPTON.—Polygon Hotel, 8 p.m. A.S.E.E. Southampton Branch. "Sound Recording on Tape and Disc," by J. F. Doust.

Friday, 24th May, to Monday, 27th May

PITLOCHRY.—Pitlochry Hydro Hotel. I.E.E. Scottish Centre. Spring meeting.

Saturday, 25th May

LONDON.—Women's Engineering Society, London Branch. Visit to A.E.I., Ltd., Research Laboratory, Aldermaston.

OXFORD.—Regent's Park College, Pusey Street, 6.30 p.m. A.S.E.E. Oxford, Reading and Districts Branch. "Applications of the Cathode Ray Tube," by C. H. Gardner.

Industrial Safety Conference

The National Industrial Safety Conference of the Royal Society for the Prevention of Accidents is being held at Scarborough from 31st May to 2nd June. At the trade exhibition which is being run concurrently with the conference about fifty manufacturers of industrial safety equipment, and various organisations, will be represented. The conference will be under the chairmanship of Mr. A. E. Elson, until his recent retirement industrial safety consultant to Samuel Fox & Co., Ltd. Meetings will be held in the Spa Theatre, Scarborough, where on 31st May delegates will be given a civic welcome by the Mayor of Scarborough, Ald. R. P. Robinson. The president, Sir Howard Roberts, will then deliver his presidential address; he will also present the Sir George Earle trophy to the 1956-57 winners. The trade exhibition will be at the Corner Café.

NEW PATENTS Electrical Specifications Recently Published

The numbers under which the specifications will be printed and abridged are given in parentheses. Copies of any specification (3s 6d each including postage) will be obtainable after 22nd May from the Patent Office, 25, Southampton Buildings, London, W.C.2.

1951

3713. Morle, C. W. (Philco Corporation).—Electrical delay circuits. 15th February, 1951. (775462.)

1952

1960. Briggs, G.—Servo-mechanisms. 23rd April, 1953. (775171.)

10404. Delapena & Son, Ltd.—High frequency induction heating apparatus. 27th April, 1953. (Addition to 714488.) (775463.)

14201. Pallemaerts, J. E. H.—Mountings for television tubes. 7th December, 1953. (775442.)

19151. Siemens & General Electric Railway Signal Co., Ltd., Austin, T. D., and Riddle, H. J. N.—Electric signalling systems. 29th July, 1953. (775353.)

19174. National Research Development Corporation.—Semi-conductor devices. 14th July, 1953. (775465.)

1953

16180. Electric & Musical Industries, Ltd.—Cathode-ray tube apparatus. 21st May, 1954. (775467.)

24546. Standard Telephones & Cables, Ltd.—Telephone subsets. 4th September, 1953. (775175.)

30651. Accumulatoren-Fabrik Akt.-Ges.—Permanently gas tight sealed alkaline electric accumulators. 5th November, 1953. (775090.)

35072. General Electric Co., Ltd., Aston, S. G. G., and Johnson, M. P.—Automatic temperature controlled ovens. 16th December, 1954. (775176.)

35222. General Electric Co., Ltd., and Hayes, A. G.—Electrical attenuators. 14th December, 1954. (775452.)

35732. Cosmocord, Ltd., and Kelly, S.—Electro-acoustic apparatus. 23rd March, 1955. (775177.)

1954

4576. General Electric Co., Ltd., and Donelan, J. A.—Apparatus for electric resistance welding. 19th April, 1955. (775428.)

5886. Deventer, H. R. Van, and Bailey, P. C.—Telephone answering and recording devices. 1st March, 1954. (775477.)

6543. Telephone Manufacturing Co., Ltd.—Polarised electromagnetic relays. 2nd March, 1955. (775302.)

7798. Walsall Conduits, Ltd.—Electric automatic circuit-breakers. 14th March, 1955. (775449.)

8899. Plessey Co., Ltd.—Thermionic valves or electron tubes. 25th March, 1955. (775277.)

10505. English Electric Co., Ltd.—Servo-mechanisms. 7th April, 1955. (775101.)

12785. English Electric Co., Ltd.—Twin motor rolling mill drives. 3rd May, 1955. (775182.)

12957. General Electric Co., Ltd., and Hayes, A. G.—Electrical attenuators. 14th December, 1954. (Divided out of 775452.) (775453.)

13286. Western Electric Co., Inc.—Semi-conductor signal translating devices and methods of making them. 6th May, 1954. (775366.)

13382. English Electric Co., Ltd.—Apparatus for the control of grid-controlled electric discharge devices. 6th May, 1955. (775105.)

14081. Parmiter Hope & Sugden, Ltd.—Electric cartridge fuses. 10th May, 1955. (775484.)

14537. Clang, Ltd., Austen, H. E., and Harwood, C. D.—Electrical fused socket adaptors or plugs. 17th June, 1955. (775305.)

15013. English Electric Co., Ltd.—Terminal devices for use with electrical instruments. 20th May, 1955. (775488.)

15264. British Insulated Callender's Cables, Ltd.—Means for the vacuum treatment, for instance for drying and impregnating, of electric capacitors and other articles. 23rd May, 1955. (775107.)

16185. English Electric Co., Ltd.—Gas-cooled dynamo-electric machines. 7th April, 1955. (775109.)

16360. Welwyn Electrical Laboratories, Ltd., Mace, P. C. D., and Nisbet, J. E.—Electrical resistors. 27th May, 1955. (775110.)

18417. British Insulated Callender's Construction Co., Ltd.—Construction of overhead electric traction systems. 22nd June, 1955. (775112.)

18483. Marconi's Wireless Telegraph Co., Ltd.—Magnetostrictive resonators. 3rd June, 1955. (775432.)

18733. Siemens Bros. & Co., Ltd.—Fluorescent materials. 3rd June, 1955. (775188.)

19311. Elektro-Mechanik Ges.—Electro-hydraulic control device. 1st July, 1954. (775491.)

19435. Taylor, J. H.—Detachable device for operating the control switch of a portable drilling machine. 7th June, 1955. (775433.)

21044. Sylvania Electric Products, Inc.—Electroluminescent lamps. 19th July, 1954. (775190.)

22459/60. Chloride Electrical Storage Co., Ltd.—Primary electric batteries. 2nd August, 1955. (775071/2.)

22470. Welt, B. P., Maslow, M., and Kreitchman, M. A.—Solenoid operated valves. 3rd August, 1954. (775345.)

23430. Cinema-Television, Ltd.—Television systems. 11th August, 1955. (775117.)

24158. Saunders-Roe, Ltd. — Direct coupled amplifiers. 30th September, 1955. (775120.)

24495 and 24500. General Electric Co., Ltd.—Manufacture of semi-conductor devices. 12th and 19th August, 1955. (775121 and 775191.)

25824. General Electric Co., Ltd., and Rous, R. F.—Thermionic valve oscillators. 6th September, 1955. (775194.)

26414. Electrical Machinery Mfg. Co.—Electrostrictive actuator. 13th September, 1954. (775127.)

26772. British Thomson-Houston Co., Ltd.—Bases for double-ended tubular electric discharge lamps. 15th September, 1954. (775350.) 26773. Lampholders for double-ended tubular electric discharge lamps. 15th September, 1954. (775351.)

31227. General Electric Co., Ltd.—Electrical counting or distributing circuits. 13th October, 1955. (775134.)

31352. British Thomson-Houston Co., Ltd.—Process for coating vitreous surfaces with powdered luminescent materials. 21st October, 1955. (Addition to 669392.) (775202.)

33002. Mullard Radio Valve Co., Ltd.—Hollow wave-guides. 15th November, 1954. (775315.)

33957. Columbia Broadcasting System, Inc.—Colour television picture display tubes. 23rd November, 1954. (775204.)

35807. Western Electric Co., Inc.—Carrier-wave modulators. 10th December, 1954. (775207.)

37076. Biffi, E.—Electrical generator. 22nd December, 1954. (775208.)

37399. Revo Electric Co., Ltd.—Electric cooking stoves. 23rd December, 1955. (775317.)

1955

48. Marconi's Wireless Telegraph Co., Ltd.—Echo sounders. 4th October, 1955. (775140.)

873. General Electric Co.—Clothes-treating machines. 11th January, 1955. (775211.)

2229. General Electric Co., Ltd., and Wright, R. E.—Electric circuits incorporating magnetic amplifiers. 18th January, 1956. (775142.)

6663. Adcola Products, Ltd.—Electrically heated pots for solder and other low melting point solids. 14th December, 1955. (775220.)

7307 and 7311. Walsall Conduits, Ltd.—Electric automatic circuit-breakers. 14th March, 1955. (Divided out of 775449.) (775450/1.)

8585. Flax, V.—Electric heating of flexible containers. 24th March, 1955. (775395.)

8708. Plessey Co., Ltd.—Thermionic valves or electron tubes. 25th March, 1955. (Divided out of 775277.) (775278.)

12637. Clarostat Mfg. Co., Inc.—High voltage variable resistors. 2nd May, 1955. (775158.)

16059. Radio Corporation of America.—Colour television demodulating circuit. 3rd June, 1955. (775152.)

17301. General Electric Co.—Electron discharge tubes. 15th June, 1955. (775241.)

18700. General Electric Co.—Thermostat devices in or for air heating systems. 28th June, 1955. (775243.)

19330. Talon, Inc.—Electric toggle switch. 4th July, 1955. (775244.)

19460. Journee, H. J.—Primary cell with an improved anode. 5th July, 1955. (775337.)

19691. General Electric Co.—Electrical resistance heaters of the tubular sheath type. 7th July, 1955. (775522.)

20373. Westinghouse Electric International Co.—Electric toasting apparatus. 14th July, 1955. (775523.)

20581. General Electric Co.—Apparatus for applying coating material to steam iron sole-plates. 15th July, 1955. (775524.)

21725. General Electric Co.—Electric pull-switches. 27th July, 1955. (775247.)

22840. Foxboro Co.—Electronic time constant system. 8th August, 1955. (775526.)

22917. Tesla, Narodni Podnik.—Magnetic system with closed magnetic circuit. 9th August, 1955. (775250.)

27803. Siemens-Schuckertwerke Akt.-Ges.—Electric plug connectors suitable for switchgear. 29th September, 1955. (775260.)

27831. Bauer, R. E.—Electric dry battery assembly. 30th September, 1955. (775416.)

27945. Sangamo Weston, Ltd.—Indicating or registering devices for meters. 30th September, 1955. (775417.)

30163. Standard Telephones & Cables, Ltd.—Crosstalk compensation in double-side-band carrier frequency systems with carrier transmission. 21st October, 1955. (775263.)

30300. Westinghouse Air Brake Co.—Electromagnetic relays. 24th October, 1955. (775421.)

30781. General Electric Co.—Totally enclosed dynamo electric machines. 27th October, 1955. (775264.)

31084. Landers, Frary & Clark.—Steam iron. 31st October, 1955. (775535.)

31329. Brown Fintube Co.—Electric heaters for gases. 2nd November, 1955. (775265.)

32766 and 32768. Pirelli Soc. per Azioni.—Joints or terminals for high tension electric cables. 16th November, 1955. (Additions to 752376.) (775083/4.)

37149. Vapor Heating Corporation.—Electromagnetic contactors. 28th December, 1955. (775269.)

1956

7488. British Thomson-Houston Co., Ltd.—Holders for double-ended tubular electric discharge lamps. 15th September, 1954. (Divided out of 775350.) (775352.)

CONTRACT INFORMATION

Accepted Tenders and Prospective Electrical Work

CONTRACTS OPEN

Where "Contracts Open" are advertised in our "Official Notices" section the date of the issue is given in parentheses

Argentina.—Water and Electricity Board. 14th August. 500, 1,000 and 2,000 kW generating sets. (E.S.B. 11505/57. Ten/25724.)* 5th September. Electro-mechanical machinery for hydro-electric plant. (E.S.B. 10620/57. Ten/25746.)*

Australia.—State Electricity Commission, Brisbane. 5th June. 11, 33 and 66 kV switchgear. (E.S.B. 10967/57. Ten/25641.)* 19th June. Alternator and feeder switchboard panels for Winton Shire Council. (E.S.B. 10965/57. Ten/25669.)*

Canada.—Winnipeg Electric Co. 28th May. 600 V station service load centre for the Great Falls generating station. (E.S.B. 11123/57. Ten/25726.)*

Chelmsford.—Essex County Council Education Committee. 25th May. Renewal of the electrical installation at Chingford Larkswood County Junior School. (See this issue.)

Colchester.—Borough Council. 8th June. Rewiring of the electrical installation in the Town Hall. (See this issue.)

Croydon.—Corporation. 22nd June. Street lighting equipment. (See this issue.)

Havant and Waterloo.—U.D.C. 25th May. Cables and fittings for one year to 30th June, 1958. Surveyor, 1, Park Road North, Havant.

India.—Damodar Valley Corporation. 13th June. 132 kV and 33 kV disconnecting switches. (See this issue.)

Iraq.—Ministry of Development, Baghdad. 17th June. Piping, pumps and tanks for Dibis and Baghdad power stations. (E.S.B. 11380/57. Ten/25653.)*

New Zealand.—Invercargill City Council. 27th May. Underground cables and equipment. (E.S.B. 11814/57. Ten/25778.)*

G.P.O., Wellington. 4th June. Porcelain fuses. (E.S.B. 11037/57. Ten/25678.)* 5th June. Non-synchronous vibrators. (E.S.B. 11038/57. Ten/25730.)*

Northampton.—R.D.C. 12th June. Electrically driven sewage pumps. Surveyor, 1, Cheyne Walk.

Northern Ireland.—Housing Trust. 27th May. Electrical work in 378 dwellings at Braniel, Co. Down. Offices of the Trust, 12, Hope Street, Belfast.

Co. Down Education Committee. 30th May. Electrical installation in Knockbreda (New) Intermediate School, Belfast. J. McCandless, consulting engineer. 6, Murray Street, Belfast.

Londonderry County Borough Council. 1st June. Electrical installations in 36 dwellings at Lone Moor Road. Housing architect, 5, Guildhall Street.

Portuguese East Africa.—Beira Railways. 12th June. Automatic telephone exchange. (E.S.B. 11209/57. Ten/25745.)*

Romford.—Corporation. 3rd June. Electric lighting installation at Manor Junior School. (See this issue.)

South Africa.—Stores Department, South African Railways. 24th May. Electric railway overhead wiring equipment. (E.S.B. 11098/57. Ten/25712.)* 5th June. Telegraph line material. (E.S.B. 11474/57. Ten/25748.)* 7th June. Hard drawn copper wire. (E.S.B. 11353/57. Ten/25711.)*

City of Johannesburg. 27th May. Distribution voltage regulators. (E.S.B. 12195/57. Ten/25812.)*

Durban Corporation. 14th June. Oil filled 33 kV cable. (E.S.B. 10533/57. Ten/25673.)*

Union Tender and Supplies Board, Pretoria. 20th June. Magneto extension bells. (E.S.B. 11354/57. Ten/25672.)*

Thailand.—Post and Telegraph Department, Bangkok. 22nd May. Electric testing meters. (E.S.B. 11251/57. Ten/25741.)*

Trinidad.—Trinidad and Tobago Electricity Commission, Port of Spain. 200, 400, 500 and 1,000 kVA transformers. (E.S.B. 9776/57. Com/13407.)*

Uruguay.—Administración General Usinas Eléctricas y los Teléfonos del Estado. 3rd July. Trunk telephone cables. (E.S.B. 10585/57. Ten/25652.)*

* Specifications may be inspected at the Export Services Branch, Board of Trade, Lacon House, Theobald's Road, London, W.C.1 (Chancery 4411; extension 769).

ORDERS PLACED

Bootle. — Housing Committee. Recommended. Electrical work in connection with housing schemes on the Park Lane estate (£2,412).—S. H. Gillies & Co.

Bromsgrove.—Birmingham Regional Hospital Board. Recommended. Rewiring electrical installation in the Barnsley Hall Hospital (£18,016).—Harry Ward.

London. — South East Metropolitan Regional Hospital Board. Wiring and fittings for the installation of lighting, power and radio systems in the wards at Dulwich Hospital, Camberwell (£3,593).—William Steward & Co.

Sheffield.—Corporation Social Care Committee. Electrical installation in new home for the aged, Greenhill-Bradway estate (£3,799).—Tinsley Electrical Co.

WORK IN PROSPECT

Particulars of new works and building schemes fot the use of electrical installation contractors and traders. Publication in this section is no guarantee that electrical work is definitely included. Alleged inaccuracies should be reported to the Editors

Ashton-under-Lyne. — R.C. secondary modern school (£111,000); Lancs county architect, County Offices, Fishergate Hill, Preston.

Barry.—Shops (20), with dwellings over, Winstone Road, Colcot estate; W. E. Chivers & Sons, Ltd., builders, Western Avenue, Llandaff.

Bristol.—Five-storey offices, Marsh Street/King Street corner site, for Northern Assurance Co., Ltd.; Troup & Steele, architects, 14, Gray's Inn Square, London, W.C.1.

Burnley.—Works extensions; North Diecasting Co., Ltd., Irene Street.

Hostel for aged people, Rossendale Road; Hitchon, Pickup & Halsted, architects, 8, Calder Street.

Cottesmore (Rutland).—County primary school, R.A.F. Station site; T. Kennedy, planning officer, County Offices, Catmose, Oakham.

Coventry.—Works extensions; L. Lenton & Co., Ltd., Eagle Street.

Dunstable. — Girls' grammar school (£136,442); Beds county architect, Shire Hall, Bedford.

Durham.—Museum (£60,000); Durham University authorities.

East Ham.—Eight-storey flats, High Street South/Central Park Road site; chief housing officer, Town Hall, East Ham, London, E.6.

Exeter.—Residential hostel for old persons, Wonford (£44,000); H. B. Rowe, city architect, Municipal Offices.

Gateshead. — Crematorium (£50,000); borough surveyor.

Great Yarmouth.—New works and extension of existing works, South Denes (£70,000); Bush Builders (Norwich), Ltd., Mile Cross Lane, Norwich.

Hinckley.—Laboratories, workshop, drawing office, and administrative section, as further stage of College of Further Education; Leicestershire county architect, 123, London Road, Leicester.

Houses (40); U.D.C. architect.

Hope (Wrexham).—Secondary modern school (£97,995) for Flints. C.C.; Edward W. Gittins & Sons, builders, Works, Johnstown, Rhos, Wrexham.

Kettering.—Flats (56), Weekley Glebe Road; borough surveyor.

London.—Airways terminal extension, Buckingham Palace Road, S.W.1; chief surveyor.

Theatre and extensions to X-ray department at Brook Hospital, Shooters Hill (£48,750); South East Metropolitan Regional Hospital Board, 11, Portland Place, W.1.

Luton.—County secondary modern school, Sundon Park (£111,015); county architect, Shire Hall, Bedford.

Middlesbrough.—Fifteen temporary classrooms at Park End School, Ladgate School, and Berwick Hills School; K. J. Caton, education architect.

Proposed Springfield County Secondary Modern School (£178,000); A. V. Clerey & Son, builders, 14, Frederick Street, Sunderland.

Sixteen shops and 32 flats at Park End, and five shops and 10 flats at Pallister Park; J. A. Kenyon, borough engineer.

Newcastle-on-Tyne.—Eight new schools during 1958-59 (£980,000) and flats in Caledonia Street, etc. (£37,000); city architect, 18, Cloth Market, Newcastle-on-Tyne.

Newport (I.O.W.).—Additional storey to administration block of Technical College; county architect, County Hall, Newport, I.W.

Northumberland.—Secondary school at Belford (£53,000); R. Slawther, builder, Alnwick.

School at Walbottle (£149,000); John Jackson & Son, builders, Corporation Street, North Shields.

Occupation centre at Ashington (£26,000); county architect, County Hall, Newcastle-on-Tyne.

Peterborough.—Church, Dogsthorpe estate (£14,000); John Lucas & Son, Ltd., Dogsthorpe Road, Peterborough.

Reading.—Factory extension, St. Saviour's Road; Gascoignes (Reading), Ltd., Berkeley Avenue.

South Shields.—Extensions in Commercial Road for S. Newman, Ltd., clothing manufacturers.

Old people's hostel, Wenlock Road (£28,000); J. Reid, borough engineer.

Stafford.—Extensions to premises in Malt Mill Lane (£35,000); A. Ravenscroft, Salter Street.

Staveley.—Bus station, Market Street; U.D.C. architect.

Teifiside.—Houses (50); R.D.C. surveyor, Council Offices, Llandyssul.

Thornaby-on-Tees.—Houses (1,000) on part of Thornaby airport site; J. L. Watson, borough engineer, Town Hall.

Tynemouth.—Houses near the Broadway and Beach Road; J. H. Rogers, builder, North Shields.

Five-storey blocks of flats at North Shields (£413,308); borough surveyor.

West Hartlepool.—Houses (164); borough architect.

Whitley Bay.—Conversion of Prudhoe Memorial Homes into hospital and convalescent home (£60,000); Newcastle Regional Hospital Board, Newcastle-on-Tyne.